THURSDAY, APRIL 29, 1915.

THE VALUE OF THE RARER ELEMENTS.

The Rare Earths: their Occurrence, Chemistry, and Technology. By S. I. Levy. Pp. xiv + 345. (London: Edward Arnold, 1915.) Price 10*s.* 6*d.* net.

THE rapidly-growing importance of the rarer elements in both theoretical and technical directions makes the above volume a welcome addition to English chemical literature. Except for Browning's "Rarer Elements," there is little of importance to turn to for information since the well-known "Terres rares" of P. Truchot, published in 1898. The valuable researches of Urbain have removed much of the obscurity that at one time surrounded many members of the yttria group, and has demonstrated the complexity of several that had been thought to be elementary, and quite recently an exhaustive study of the very rare earth scandia by Sir William Crookes has directed attention to this somewhat neglected branch of science.

The title of the present work is rather misleading, for the author deals not only with the rare earths proper, bodies that have always been a perplexity to both the chemist and the theorist, to the former on account of the extreme difficulty that attends their separation and isolation (they have a provoking habit of often turning out to be complex even after their isolation) and to the latter on account of the hopelessness of finding a rational place for them in any of the periodic classifications that have appeared since the original work of Newlands and Mendeléeff. The author also discusses the elements zirconium, thorium, uranium, titanium, the incandescent mantle industry, and the manufacture of artificial silk! These latter are of great interest and importance, but one would scarcely expect to find them in a book under the title of "The Rare Earths."

The book opens with an interesting and suggestive introduction by Sir William Crookes, whose work on rare earths is well known, his numerous researches in this field extending over the last thirty-five years. His remarks refer chiefly to the closely allied elements of the cerium and yttrium groups, and with his characteristic forethought he states his conviction that by following the study of these bodies to their utmost limits "we may arrive at the explanation of what the chemical elements really are, and how they originated, and discover the reasons for their properties and mutual reactions."

The work is divided into three parts: The occurrence of the rare earths; the chemistry of the elements; and the technology of the elements. Each section is treated in detail, and contains a large amount of information, showing that the author has a thoroughly practical knowledge of his subject.

To have at hand in one volume such a store of mineralogical, chemical, and technical detail is in itself a great boon, and the work is likely to become a standard of reference.

In the chapter which deals with the rare minerals a somewhat novel classification is adopted "for the sake of convenience," and an alphabetical list is given of those minerals which contain the yttrium and cerium groups as well as titanium, zirconium, thorium, scandium, etc.; the list is said to include all but a few unimportant members of this class; of these the larger number, printed in heavy type, are fully discussed in a later section. No mention is made of carnotite, the hydrated vanadate of uranium and potassium that has recently come into prominence as a source of radium, nor of the brown wükite that occurs with the black variety in Finland. As a whole, however, the list is a valuable one; it gives the name, composition, specific gravity, hardness, etc., of some 150 minerals that could otherwise only be found by lengthy search in recent mineralogical literature.

The next section, occupying some sixty pages, discusses the minerals in detail, and contains an account of the interesting mineral thorianite, from Ceylon, containing 55—79 per cent. thoria and a considerable amount of helium from which radio-thorium has been prepared by Hahn; also the recently-discovered mineral thortveitite containing 37 per cent. of scandia.

Prominence is given to the thorium and cerium minerals on account of their bearing upon the mantle industry; in this connection the chapters on the monazite sands is of great practical value, although carrying as little as 2 per cent. of monazite, the Brazilian deposits are of enormous extent and have become the chief source of the thoria that is needed for the mantle industry. Besides the Brazilian deposits, monazite occurs in quantity in Canada, India, South Africa, and in North Carolina, where in 1906 the material was successfully worked by the British Monazite Company, representing the South Metropolitan Gas Company, of London. At this juncture, however, the price of thorium nitrate was suddenly lowered 50 per cent. by the German syndicate which largely controlled the Brazilian output; this caused the British company to cease operations, which have not been resumed. The American company working upon the same material shared a like

fate, and the German syndicate, together with the Austrian Welsbach Company, now practically meet the world's demand. What effect recent events will have upon this state of affairs remains to be seen, but it looks as if great opportunities are opening out for English and American technologists if they will but take them.

In a short chapter devoted to the radio-active minerals, reference is made to the recent estimation of the atomic weight of the lead contained in them; if this element is the end-product of the thorium disintegration, the *isotope* of Soddy, its atomic weight should be slightly higher than that of ordinary lead; the value found in a recent determination is 208·4, a result surprisingly in accord with theory.

Part ii. deals with the chemistry of the elements, and this section, occupying some 130 pages, is perhaps the most valuable part of the book. It commences with a discussion of the properties of the elements of the yttrium and cerium groups, and of the methods for their separation; the greatest success appears to follow the method of fractional crystallisation, first successfully applied to didymium by Welsbach in 1885, when he succeeded in separating that supposed element into two bodies, having slightly differing atomic weights, naming them neo- and praseo-dymium; it will be remembered by some that the values published at the time by Welsbach were inverted, praseodymium being given at 143·6 and neodymium as 140·8, and it was not until 1898 that Brauner discovered and directed attention to the mistake.

The discussion of the spectrum examination is a little disappointing; the use of the spectroscope in the analysis of the rare earths is of immense importance; the absorption spectra can now be photographed from the extreme ultra-violet down to the least refrangible limit of the visible spectrum if a suitable source of light is combined with the panchromatic plates that are now on the market.

In dealing with emission spectra it is suggested that to observe spark spectra one pole of an induction coil is embedded in the oxide to be examined and a spark passed! This seems to be a very unusual procedure; in general practice the spark is either passed between platinum wires in a strong solution of the earth or else carbon rods saturated with the solution are used as electrodes; reference is made to the "reversion spectrum" discovered by the late Lecoq de Boisbaudran, but no details are given; as in some cases this method is of considerable value, it may be worth while to note that it is described in the *Comptes rendus* for 1886 (vol. cii., p. 153).

We must take exception to the rather summary dismissal of the kathode luminescence spectra discovered by Sir William Crookes some years ago; it is stated that the researches of De Boisbaudran, Baur and Mare, and Urbain have shown that these spectra were due to minute traces of a coloured earth in a large quantity of a colourless one, and that the sensitiveness of the method is so great that it cannot be employed for the ordinary purpose of chemical analysis; this may be partly true, but there is abundant evidence of the value of the kathode spectra when applied to the rare earths if the technique of the application is thoroughly understood. The sulphates of many of the earths give discontinuous spectra of great beauty and minute detail quite distinct from the nebulous luminosities produced by mixing coloured and uncoloured earths and submitting the mixture to the action of kathode rays; the oxides also, when in a state of purity and under certain conditions, give rise to a further novel series of characteristic phosphorescence spectra, and it is a matter of regret that this method of analysis has not received the attention that it deserves. We feel that the possibilities connected with it are too valuable to allow it to be lightly set aside as worthless.

For the general examination of the rare earths arc spectra are stated to be the most trustworthy, and a valuable feature is the inclusion of lists of the dominant lines in the spectrum of most of the elements.

The last section, the technology of the elements, is largely occupied with an account of the "mantle" industry; from a very interesting historical sketch it appears that the employment of the rare earths had been suggested for the production of light from very early times; mantles of platinum coated with lime and rare earths were used so far back as 1839, and mantles made from gauze that had been impregnated with lime and magnesia were used in 1849. The success that has followed the invention of Auer von Welsbach is due in great measure to the accidental discovery that the combination of about 1 per cent. ceria with thoria greatly increases the luminosity of the material, and this composition is now universal.

The commercial preparation of thorium from monazite is fully set out, and the various fibres used for forming the skeleton of oxide are described. Cotton has been replaced by ramie thread, and this in turn is giving way to artificial silk and similar materials, which on account of their uniformity are found to produce more robust and lasting skeletons.

In addition to the mantle industry there are already many other valuable technical applications

of the rare elements, and some of the more important are given. Zirconium in particular has properties that render it valuable in many ways; the metal has a very high melting point, and is so hard that it can be used as an abrasive and for glass-cutting; the oxide is largely used in the manufacture of crucibles and furnace linings, and for many other purposes; it has even been suggested as a toilet powder. Among the properties of the metals of the cerium group is the power of forming pyrophoric alloys; cerium with 20 per cent. of iron is said to form an alloy which gives showers of sparks when scratched or struck, and "lighters" made from this and similar alloys are already in use.

The last chapter of the book is devoted to a discussion of the technical possibilities of titanium and its compounds; there are many uses suggested for this interesting element; its very high melting point, 2350° C., renders its employment in metallurgy difficult unless first alloyed with iron, as ferrotitanium; from this many valuable alloys have been formed.

But enough has been said to show that Mr. Levy's book is no ordinary text-book; it is original in its design, contains a vast amount of valuable information connected with the rare earths and the minerals in which they are found, and gives a very complete account of the present technical application of many of them; and it offers great encouragement for further research in this interesting and little-worked branch of inorganic chemistry. JAMES H. GARDINER.

ABNORMAL PSYCHOLOGY.

(1) *Psychopathology of Everyday Life.* By Prof. S. Freud. English Translation with Introduction by Dr. A. A. Brill. Pp. vii+342. (London: T. Fisher Unwin, 1914.) Price 12*s.* 6*d.* net.

(2) *The Unconscious. The Fundamentals of Human Personality, Normal and Abnormal.* By Dr. M. Prince. Pp. xiv+549. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

(1) THERE has been a rapid growth of interest, during recent years, in the theoretical explanation and practical treatment of mental diseases, especially of those so-called "borderland" cases between the normal and the definitely insane. The problems involved have aroused vigorous controversy, and the most conflicting views have been put forward by different schools of thought. Among the exponents of these various doctrines two of the most distinguished are Prof. Freud, of Vienna, and Prof. Morton Prince, of America.

Broadly stated, Freud's psychological system is based upon a fundamental distinction between two classes of memories and mental tendencies, viz., ordinary memories and tendencies and those that have for one reason or another been *repressed.* The latter are those involved in mental conflicts and accompanied by pain. They constitute the true "unconscious" of the mind. The other memories are classed by Freud as "pre-conscious." Unconscious memories and mental tendencies retain their original intensity, and although outside of consciousness continue to act, and from time to time affect consciousness. "Like the shades in the Odyssey," says Freud, "they come to life again as soon as they have drunk blood." When especially intense, or when the repressing power of the mind is in one way or another diminished, they may produce the symptoms of hysteria and of other forms of mental disease. But they are also the cause of dreams in normal persons, and of the apparently unintentional mistakes in speech, writing, and other actions, to which we are all more or less subject when our attention is distracted. Freud tries to sustain this latter view in his "Psychopathology of Everyday Life." He contends that the method of psychoanalysis,[1] or free association, demonstrates conclusively that such slips of memory, speech, and writing are really intentional, and due to the concomitant working of unconscious mental tendencies. In his view the problem for psychology is not why we are able to remember, but why we come to forget, and his own solution of the problem is that we forget the unpleasant, except when special factors make this forgetting impossible.

The theory is a comprehensive one, and not so easy to refute as might at first sight appear. There can be no doubt that in quite a number of cases repression plays an important part in the forgetting of unpleasant incidents, and that unconscious mental tendencies sometimes prove their existence by disturbing our speech and other acts. But the exceptions are numerous, and even some of the cases which Freud himself analyses at length seem to admit of other explanations. The book is extraordinarily interesting, however, and full of hints for the student of human nature.

(2) Dr. Prince's book is an excellent introductory text-book for medical psychologists. It sets out very clearly the various senses in which the word "unconscious" has been used by different writers, and shows how important the concept, when adequately defined, is for abnormal psychology. Morton Prince distinguishes what he calls the co-conscious from the unconscious.

[1] See "What is Psychoanalysis?" NATURE, February 5, 1914.

The former is the split-off or dissociated consciousness demonstrable in cases of hysteria, etc., the latter is to be thought of best in physiological terms. He recognises the existence of repression, in the Freudian sense, in certain cases, but is unable to verify its universal existence in pathological cases. Many of the instances which he quotes are also strong evidence against Freud's view that sexual experiences, especially those dating from early childhood, are invariable factors in the production of neuroses.

Towards the end of the book there are some excellent chapters on instinct, emotion, and sentiment, which form an important contribution to the question of the nature of personality. The book will be found extremely helpful by those medical men who desire a well-balanced statement of the facts and theories of medical psychology at the present day. WILLIAM BROWN.

PASTEUR AND PREVENTIVE MEDICINE.

(1) *Pasteur and after Pasteur.* By Stephen Paget. Pp. xii+152. (London: A. and C. Black, 1914.) Price 3*s.* 6*d.* net.

(2) *On Pharmaco-Therapy and Preventive Inoculation applied to Pneumonia in the African Native, with a discourse on the Logical Methods which ought to be Employed in the Evaluation of Therapeutic Agents.* By Sir A. E. Wright. Pp. xii+124. (London: Constable and Co., Ltd., 1914.) Price 4*s.* 6*d.* net.

(1) IN this volume, one of a series of manuals on medical history, Mr. Stephen Paget, with his usual facile pen, outlines the life of Pasteur. Commencing with his early years, we have a glimpse of Pasteur's home and of the ideals which influenced his whole life:—

"Work hard, honour your country; put spiritual things above material, and other people before yourself; have courage, have patience." . . . "Work; love one another," he writes to his little sisters. "Once you have got into the way of working, you cannot live without it. Besides, everything in this world depends on it."

An excellent description follows of his chemical researches, his study of tartaric acid and of the tartrates, and the foundation of stereochemistry therefrom. In January, 1849, Pasteur is offered and accepts the professorship of chemistry at Strasbourg:—

"Friendship met him on the threshold, and Love was waiting for him just across it. Friendship was young M. Bertin, who had been at school with him, and was now professor of physics in Strasbourg: Love was Marie Laurent, a daughter of the rector of the academy. . . . Within a month, he had sent to her father his formal proposal of marriage. At the end of May they were married. She was everything to him: without her, his work would never have been accomplished: he would have died, long before he did, under the strain of it. To write of him, is to be writing of her: the two lives are one, from 1849 to the day he died."

Pasteur's studies on fermentation and its influence on Lister's work are next discussed, and a beautiful little picture is given of Lister, the man:—

"In 1893, the death of Lady Lister took the delight out of his life. . . . To recall him, is to think, first, of the dignity, gentleness, and refinement of his face: its delicate colouring, the tranquil, almost dreaming, look of his eyes. . . . He smiled, not laughed: a smile of singular beauty, but hard to interpret. . . . Tired, lonely, and, long before he died, broken in health and in the enjoyment of living, one thinks of him, still as a man serene through controversy, a spirit of invincible patience and of radiant purity."

One of the traits of Lister's character, which the reviewer likes best to remember, was his intense concern for the welfare of the patients who came under his care—an untoward incident was a real grief to him.

Subsequent chapters deal with Pasteur's other researches—diseases of silkworms, anthrax, chicken-cholera, rouget—culminating in his work on rabies, soon after which he began to fail:—

"Then came enfeeblement, a year of quiet resignation; and, in September, 1895, his death. It is recorded of him that he died holding the crucifix in one hand, and in the other his wife's hand. Here was a life, within the limits of humanity, well-nigh perfect."

All that is mortal of the great master rests—most fittingly—in the beautiful little chapel in the Pasteur Institute, Paris.

Pasteur's work is fundamental and must be regarded as the starting-point of modern bacteriology and of experimental immunity and preventive medicine. Mr. Paget is able from a consideration of all that has since been accomplished in the prevention of diphtheria, plague, cholera, typhoid, and yellow fevers, malaria and Malta fever to show how much we owe to the genius of Pasteur.

We heartily congratulate Mr. Paget on his book, which is deeply interesting, and holds the attention from start to finish.

(2) Three topics are dealt with by Sir Almroth Wright in this book: first, the use of an organic copper compound "optochin" for the treatment of pneumonia; secondly, the nature of the pneumonia which attacks the native labourers in the Rand mines, and the employment of prophylactic inoculations to prevent it; and thirdly, a discussion of the logical methods which ought to be applied

in inquiries into the efficacy of therapeutic agents as applied in actual practice. The last-named would perhaps have been better published separately, and need not be further considered here.

As regards "optochin," it is found that this drug exerts a specific bactericidal action on the pneumococcus in high dilutions in serum as well as in watery solution. It has been successfully used as an application in local pneumococcic affections, and though some have been favourably impressed with it in the treatment of pneumonia, others have not found it to be of value. There is also some risk to eyesight in its use.

The pneumonia of the Rand was found to be a pneumococcal infection, and the native seems naturally to possess much less immunity towards the pneumococcus than does the white man. Various trials were made of pneumococcus vaccine as a preventive of pneumonia, and it is finally recommended that a dose of 1,000 millions of pneumococci cultivated in glucose blood broth might be appropriately employed as an ordinary prophylactic dose, as this was found considerably to reduce the incidence of pneumonia among those treated, as well as reducing the mortality if pneumonia occurred among them.

A very large amount of experimental work was carried out in this inquiry by Sir Almroth Wright and his collaborators, and the manner in which the results were controlled and are tabulated are models of what a scientific investigation should be, and form a valuable contribution towards the control of a disease which causes serious loss of life, as well as being one of considerable economic importance in the Rand. R. T. HEWLETT.

ELECTRICAL ENGINEERING.

(1) *American Handbook for Electrical Engineers: a Reference Book for Practicing Engineers and Students of Engineering.* Compiled by a staff of specialists. Harold Pender, editor-in-chief. Pp. xviii+2023. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 21*s.* net.

(2) *Electrical Engineering in India: a Practical Treatise for Civil, Mechanical, and Electrical Engineers.* By J. W. Meares. Pp. xxxvi+517. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co., 1914.) Price 15*s.*

(1) IN its thousand pages this "American Handbook" contains information on an enormous variety of subjects arranged alphabetically from "Abbreviations" to "X-Rays." The work is a sort of combination of a library of text-books with a collection of formulæ and data. In the latter department, which must be regarded as its true field, the book will be found of great service to electrical engineers, but the utility of the text-book portion is, perhaps, open to doubt.

Each section appears to have been written by a man having a thorough and practical knowledge of the subject, and the theoretical and descriptive matter is excellent so far as it goes; where it bears directly on the tabulated matter it is also most useful. But the necessary limitations of space prevent it from being anything like a satisfactory substitute for the detailed text-book. We get just a very brief summary of the leading facts, but we are also given references to other books in which fuller information can be obtained.

Although we would not agree with everything contained in the book (for instance, we do not approve of "abohms," "abamperes," and so on, and do not even admit any necessity for the so-called "absolute" systems of units), we must say that the volume is a useful accessory to the electrical engineer's desk or library.

(2) This book contains a considerable amount of information on electrical matters with special reference to the conditions as to climate, cost, and legislation as they exist in India, but we have some difficulty in imagining a class of engineers to whom it will be really useful. The elementary matter is too scrappy, and too much jumbled up to be of service to a beginner, or even to one who has forgotten; to the man who knows already it would be sheer waste of time to read it.

There is much descriptive matter, but there are very few illustrations; without them the written matter is almost worthless. Most engineers will, we think, prefer a good standard text-book, of which there are a few, for getting up the elementary theory, and one of the well-known "pocket-books" for tabulated data.

DAVID ROBERTSON.

OUR BOOKSHELF.

English Folk-song and Dance. By F. Kidson and M. Neal. Pp. vii+178. (Cambridge: At the University Press, 1915.) Price 3*s.* net.

IT is only in recent years that with the active collection and study of European folk-lore the folk-song and folk-dance have begun to receive the attention which they deserve. The collecting of English folk-songs, begun by the Rev. J. Broadwood in 1843, has since that time been actively prosecuted by Miss L. Broadwood, W. Chappell, Dr. Barrett, and Mr. Baring Gould. In 1898 the Folk-song Society commenced its labours, and has year by year added to our knowledge of British and Irish folk-music. A summary of the progress already made and instructions to the collector were badly wanted. This has now been supplied in the present book, which deals satisfactorily with the problem of the origin of folk-music, and fully describes the methods of nota-

tion. The songs of the folk are classified under the heads of narrative ballads, love and mystic songs, pastorals, the songs of the poacher and the highwayman, the soldier and the sailor, the pressgang, hunting, sporting and labour songs, carols, singing games of children, the popular street ballad, and the broadside.

As for the folk-dance, much of the knowledge which we possess is due to the enthusiasm of Mr. Cecil Sharp, who has hunted down the veteran dancers, and taught them how to instruct the minor societies which have been started in almost every large centre. The authors deny that the Morris dance is connected with the Moors, and prefer without good reason a Celtic derivation which makes it to mean "noble." The suggestion that it may be in part due to the Salii or leaping priests of Rome is hazardous; there is more to be said for the theory which connects some of the figures with a primitive sun-worship. The sword-dance seems to be derived from some primitive rites of fertility. The manual is a good introduction to the subject, and the bibliography and illustrations leave little to be desired.

Masonry as Applied to Civil Engineering. By F. N. Taylor. Pp. xi+230. (London: Constable and Co., Ltd., 1915.) Price 6*s.* net.

THE early part of this book contains descriptions of the various kinds of stones used in civil engineering, together with the methods of working and handling them. This portion cannot be described as altogether complete in itself; there are many references to another book by the same author. There is a certain off-hand manner in the treatment which has led to one, at least, unfortunate result. On p. 23 calculations appear giving the load which can be raised by a set of Weston's blocks when a given pulling force is applied. No allowance has been made for friction, hence the result of the calculation is altogether misleading.

In the later portions of the book the author deals with retaining walls, dock walls, dams, bridges, towers, monolithic and block concrete construction, shoring, and underpinning. It is probable that the reader will derive more benefit from the descriptions and drawings given in these portions than from the very brief theoretical discussions and calculations. On p. 43 there is an illustration showing a surcharged wall, together with a few lines of description supposed to indicate how to obtain the thickness of the wall. There appears to be some omission in the illustration; it is impossible to grasp the author's meaning. The treatment of the wedge method on p. 45 is imperfect, and again there appears to be omissions in the illustration.

In general, the author gives formulæ without any explanation of how these are derived. We do not think, therefore, that the book is likely to meet the requirements of modern students, who, for the most part, desire to be perfectly clear regarding the derivation, limitations, and assumptions involved in any formula which they are called upon to use in design.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Nature of Gas Ions.

OUR knowledge of the nature of gas ions is derived mainly from measurements of their mobility in an electric field. Experimental evidence has shown that as the pressure (p) is altered the mobility (k) of the ion alters generally in accordance with the law, pk=constant; when this law holds good it is safe to conclude that the ion remains unaltered at the different pressures. One of the most interesting results of experiment is that in the case of the negative ion formed in air the product pk increases as the pressure is diminished below about 10 cm.; this result indicates a simplification in the nature of the negative ion at the lower pressures. Prof. Townsend and his students have examined this phenomenon in great detail, and have come to the conclusion that the velocity (v) of the ion should be expressed as a function of the field (X) and the pressure (p) in the form $v=f(X/p)$, indicating that the nature of the ion depends on the field and the pressure. In his recently published treatise Prof. Townsend concludes that the negative ion in a dry gas is in general a cluster of molecules which for a certain range of electric forces and pressures passes through a transition stage until finally, when X/p exceeds a certain value, the negative carriers are practically all electrons.

In some experiments recently undertaken to determine the mobilities of the ions formed by the radiation from polonium in thoroughly dried air, I have been led to conclusions essentially different from those now generally held. From a pressure of one atmosphere down to about 8 cm. the results were normal; at pressures below 8 cm. the negative carriers were found to consist of two kinds, electrons and ions, the former increasing in number relatively to the latter with diminishing pressure. In no instance was there any evidence of an intermediate or transition stage, the separation between the faster and the more slowly moving carriers remaining throughout clear and distinct. I was able to measure the velocity of the negative *ion* at all stages until resolution between the two kinds of carriers was no longer practicable, and it was ascertained that the value of pk remained constant from one atmosphere down to the lowest pressure employed (1/7 mm.), indicating that the negative ion remains unaltered in nature over this wide range of pressures.

The fact that electrons exist in dry air at the lower pressures is, of course, well known, but at a pressure of 12 mm. the ions constitute at least 80 per cent. of the negative carriers and at 1/7 mm. more than 50 per cent. The proportion of ions and electrons depends solely upon the pressure, the effect of the field being for the most part small or negligible. For the negative ion at all pressures v was found to be directly proportional to X/p; there seems to be no necessity for introducing any unknown function of X/p.

The fact that the electrons travel through several centimetres of a gas at pressures as high as 8 cm. without attaching themselves to neutral molecules is remarkable, and seems to imply that the distribution of carriers between ions and electrons must be determined immediately after the act of ionisation; it would appear that the electron has to be fired into the mole-

cule above a critical velocity, otherwise attachment is no longer possible.

It was found that the positive ion remains unchanged in nature down to 1/20 mm., which was the lowest pressure tried.

An account of these experiments will appear shortly in the *American Journal of Science*.

E. M. WELLISCH.

Yale University, Sloane Laboratory,
New Haven, Conn., April 6.

Migrations in the Sea.

THE terms "anadromous" and "catadromous" are employed to distinguish fish which leave the sea to spawn in fresh water and fish which migrate from fresh water to the sea when they reach maturity. Gilson, in his paper, "L'Anguille" (1908, *Ann. d. l. Soc. roy. Zool. et Malacol. de Belgique*, T. 43), proposed that the words should be used to define migrations to and from fresh water. The salmon, for example, is catadromous as a smolt, anadromous as a grilse, and so on. But unless new terms are to be created the words must be given a much wider significance than Gilson has suggested. The migrations of fish from the lower part of a river to the higher reaches, from a river to a stream, from the deep region of a lake to the shallows only differ in degree from the anadromous migration of the salmon. It cannot be said either that there is any difference requiring a new term in the migration of a fish from the sea into the lower part of a river or into an estuary. A fish which migrates from relatively deep water to the coast may also be said to have made an anadromous migration. There are species which may spawn in fresh or brackish water, and species which may spawn in salt or in brackish water. In short, it may be said that fishes present every degree of anadromous migration from mid-ocean to the upper limits of streams, and corresponding catadromous migrations. It is now proposed, therefore, that these words should be used to indicate the direction of the migration, however small or great that migration may be, whether passive or active, pelagic or demersal, seasonal or spawning.

But even with the wide meaning here suggested the words cannot be applied to an important feature of migrations in the sea—migrations brought about by current. The Gulf Stream is utilised by fish and other organisms for the conveyance of eggs and larvæ and young to, or towards, the continent, and its branches are no less importantly taken advantage of to convey the products from the spawning ground to a region which may be at some considerable distance. The drift may often be said to be an anadromous one, but it is sometimes catadromous, and frequently could not be defined by either term. The migration of the mature fish is in contrast to the drift of the larva.

This may be illustrated by reference to a species not a fish—the common edible crab, *Cancer pagurus*. The crabs on the east coast of Britain migrate, seasonally, catadromously from the coast for winter and anadromously to the shore region for summer. The mature females after ecdysis, sooner or later become ripe, and in response to the impulse thus conveyed migrate northwards along the coast. During or after this migration they become "berried." The larvæ, when liberated, are planktonic, and are carried by the current to the south. If there were, as there is some degree of evidence to show that there are, particular regions which present large associations of berried females, the young crabs would reach the bottom most numerously in areas to the south, which may be said to be related to the regions where the larvæ are liberated.

Thus with regard to this species there is a migration against the current of the mature females and a migration with the current of the larvæ, and these migrations are clearly quite distinct from the seasonal movements which characterise the species at the other periods of life.

The relationship of the spawning ground to the region where the demersal fry are deposited is better defined in the case of many of our species of flat fish and round fish, since it results in the formation of schools of seasonal migrants.

To define these and other migrations which are intimately associated with currents it is necessary, therefore, to introduce two terms which will serve to indicate movement against the current and with the current. My colleague, Prof. J. Wight Duff, recommends a Latin root, *natare*. The words suggested therefore are *contranatant*, swimming against the current, and *denatant*, swimming or drifting with the current. The words *contranatation* and *denatation* are also available to indicate the act or habit of migration against or with the current.

A. MEEK.

Marine Laboratory, Cullercoats, Northumberland.

A Mistaken Butterfly.

IN this connection the case should be recalled of the Cleopatra butterfly of southern France and Italy, the close relative of our English Brimstone. By waving a grass-green butterfly net in its vicinity I have frequently attracted the yellow and orange coloured males, which will flutter after the net and endeavour to settle on it. The female is similarly coloured to the female Brimstone, but is rather larger. A blue net fails to attract them.

G. H. BRYAN.

THE "CRACKING" OF OILS AND ITS COMMERCIAL USE.

THE great consumption of petrol as a motor fuel, which last year, in spite of the disturbing element of war, rose to the enormous volume of 120 million gallons in England, and to nearly ten times that amount in America, has led to the attempt being made to add to the natural supply by the so-called "cracking" of the heavy residual oils left after the petrol and the lamp oil have been distilled off from the crude oil.

The term "cracking" is one of those delightful Americanisms which express so exactly the meaning we wish to impart that it has been adopted universally—when a molecule is decomposed it is broken up: when it is merely resolved into simpler compounds it is "cracked." The term first came over with carburetted water gas, when the oils fed into the carburetting chamber were said to be "cracked," *i.e.*, converted into hydrocarbon gases of high illuminating value, but not "broken" into carbon and hydrogen.

A less violent form of the same operation can be utilised to convert the heavy hydrocarbon molecules in oil of high specific gravity and boiling point into volatile liquids fitted for use as a substitute for petrol. Most of the processes for doing this are based on a paper read by Sir Edward Thorpe and John Young before the Royal Society in 1871. This historical memoir was the first and only really scientific attempt to explain the actions that led to an increase in the yield of light hydrocarbons from a heavy oil under certain conditions of distillation, an action that

had been first noticed in America in 1861, and was patented in England by James Young in 1865.

Thorpe and Young took 3½ kilos. of paraffin wax obtained from shale and distilled it in an iron mercury bottle connected with a second by a bent tube carrying pressure gauge and stop-cock. The distillation was carried out over an open coal fire, one bottle containing the paraffin being heated, whilst the other acted as a condenser. In about four or five hours the distillation was completed, the pressure throughout being kept at 25 lb., and a magma of oil and unaltered paraffin resulted, which could be liquefied completely by the warmth of the hand. Four litres of liquid hydrocarbons were obtained, and on a preliminary factionation gave:—

Below 100° C.	...	...	...	0·3 litre
100–200° C.	...	...	...	1·0 „
200–300° C.	...	...	...	2·7 litres

Repeated distillations of the portion boiling below 100° C. resolved it almost entirely into three fractions:—

(1) 32°–38° C.,	consisting	of	pentane and amylene
(2) 65°–70° C.,	„	„	hexane and hexylene
(3) 94°–97° C.,	„	„	heptane and heptylene

Members of the acetylene and benzene series were absent.

Extended experiments with the portions distilling from 100° C. up to 300° C., and the solid hydrocarbon left above 300° C., showed them to be mixtures of saturated hydrocarbons and olefines. In the fractions distilling below 100° C., these two classes of bodies were in nearly equal proportions, but above that temperature the proportion of paraffin hydrocarbon to olefine became gradually larger as the molecular weight increased.

In cracking a heavy oil there are two factors that govern the course of the actions taking place, and these are temperature and pressure. The first loosens the groups of atoms that build up the complex molecule; the second to a great extent determines whether the action is a dissociation or a decomposition.

The temperature at which the dissociation takes place is above the boiling point of the heavy hydrocarbons, and if no pressure is employed the oil vaporises and the amount of alteration that takes place is small and depends on the local heating of the vapours as they are formed, but if pressure is used the necessary temperature for dissociation is reached, and by suiting the temperature and pressure to the particular mixture of heavy hydrocarbons being dealt with, the maximum of alteration with the minimum of decomposition can be attained. Directly the action commences to be decomposition, gases are evolved, and carbon with heavy asphaltic bodies make their appearance in the residual liquid, while the volume of gas affords an index to the amount of decomposition taking place.

The more complex the original molecule the lower the temperature needed to loosen the bondage of the groups it contains, and therefore the easier to prevent decomposition; hence Thorpe and Young, using a nearly uniform compound like paraffin, were able to dissociate it entirely at a temperature of between 300° C. and 400° C., and prevent decomposition by distilling and condensing under a pressure of 25 lb., but when we come to deal with a mixture of complex molecules, such as are found in Solar oil, the dissociation temperature of some is well above the decomposition temperature of other molecules, and the temperature at which it is best to carry on the conversion can be found by determining the temperature at which part of the oil just commences to decompose, *i.e.*, gives off 10 or 12 cubic ft. of gas per gallon at atmospheric pressure, and then to regulate the pressure so as to prevent any gas being evolved.

With a Solar or other residual oil, what is wanted is a temperature round about 500° C., and a pressure that may run up to 1000 lb. or more if heavy oils are being treated. It is also clear that the heated hydrocarbons must be cooled down under pressure to prevent the chance of a decomposition temperature existing in the liquid and to prevent the escape of the more volatile products of the conversion as vapours.

It was this principle that was embodied in the apparatus which was patented by Sir Boverton Redwood and Sir James Dewar in 1889, and has been copied in the Burton process by which, at the present time, thousands of tons of heavy residual oils are being converted into lighter products by the Standard Oil Company. In both cases the form of apparatus is identical; large vessels or boilers are employed, and the pressure is restricted to 4 or 5 atmospheres, whilst the temperature is 400° C. to 500° C.

Burton's patent was granted on the grounds that by his process only hydrocarbons of the paraffin series were formed, whilst in all previous processes a mixture of the saturated and unsaturated series was produced, this idea being due to the fact that the bulk of the unsaturated hydrocarbons formed were naphthenes.

The inventor of another process obtains greater safety by heating the flowing oil in a coil of iron tube heated to about the same temperature (450° C.) in a bath of molten lead at a pressure of 40 to 50 atmospheres, the oil then flowing to a second coil in a water condenser; this process differs from the previous ones by the pressure being kept sufficiently high to prevent any vaporisation. These processes may be taken to represent simple conversion, and the products found in the low boiling portions are chiefly paraffins, olefines, and naphthenes.

A very interesting process for making "cracked" spirit is that devised by Mr. W. A. Hall, in which dissociation, decomposition, and recombination all play a part, as after vaporising the oil and passing the oil vapour at a rapid rate of flow through a great length of tube heated to about 600° C. under a pressure of 60 lb., he suddenly lowers the pressure by allowing the heated and decomposing oil vapours to pass into

a 12-in. column and then through dephlegmators, which cut out the heavier portions of the residue, the vapours and gases passing on into a condensing chamber, where they are compressed to 100 lb., and under this pressure go through the condensing coils. There seems to be an endothermic reaction taking place during the condensation by pressure, as a fall of temperature takes place where one would have expected a rise from the compression, and the liquid finally condensed contains not only gas in solution, but excessively volatile hydrocarbons evidently formed by the nascent gases attaching themselves to other molecules or polymerising. Such a spirit is far more complex than one formed by dissociation acting alone, as, besides the paraffins, olefines, and naphthenes, we also find aromatic hydrocarbons, acetylenes, and bodies like hemiterpene and terpenes.

During the past ten years several processes have been introduced in which steam or water has been introduced with the oil into the cracking ducts, the idea being that hydrogen from the water would affix itself to the heavy hydrocarbons and hydrogenate them into lighter hydrocarbons; to aid this action catalysts have been frequently used, nickel being the most popular.

The idea of the use of nickel as a catalyst is twenty-seven years old, as, in 1888, Ludwig Mond took an English patent, 12,608 of that year, in which he mentions the treatment of hydrocarbons, together with steam, by passing them through heated vessels containing fire-brick or iron oxide, and he states that if metallic nickel is used in place of the iron oxide, then only a moderate temperature is required.

About 1900, Sabatier and Senderens studied the action of nickel and other metallic catalysts on the hydrogenation of oils, and in the following years there were many more patents taken covering its use. Still later there were a large number of patents taken in America by Dr. Day, Ellis, Kayser, and others, dealing with the use of nickel as a catalyst.

Mond, Sabatier, and Senderens all recognised that such surface action as the nickel exercised took place only at temperatures below, at any rate, 300° C., but the more recent exploiters of the idea have drifted back to the temperatures one would use for cracking, not for hydrogenation.

Mr. Edgar A. Ashcroft has been doing some extremely interesting and highly suggestive work. Starting with the theory that the crude oil, as we obtain it from the well, represents a mixture in which the groups of atoms forming the molecule have, under the influence of temperature and pressure existing during the formation of the oil, arranged themselves as compounds in a proportion that has given a natural equilibrium, he suggests that if the crude oil be distilled so as to eliminate the lighter fractions and the residue be again subjected to the same temperature and pressure as that at which it was formed, a natural equilibrium will again be reached by the formation of a mixture akin to the original crude oil, from which more light fractions can be distilled. In the same way, when coal is destructively distilled, the gas and tar represent a molecular arrangement which is in a state of natural equilibrium, so that by taking a middle fraction of the distillation of such tar, say creosote oil, and subjecting it to heat and pressure, tar, with its low boiling hydrocarbons, middle fractions, and pitch, should be again formed. That this is so is seen from the following experiment.

Two hundred c.c. of creosote oil, distilling between 240° C. and 350° C., were heated in an autoclave up to 490° C., which gave a pressure of 100 atmospheres; on allowing to cool down 180 c.c. of tar and 5 litres of very rich gas were found to have been formed. The tar on distillation gave :—

	c. c.	
First runnings, up to 170° C.	... 10	Benzol, toluol, and solvent naphtha
Carbolic oils, 170°–240° C.	... 20	Phenols, naphthalene, and anthracene
Creosote oils, 240°–270° C.	... 20	
Anthracene oils, 270°–350° C.	... 20	
Pitch (very fine) ...	 30	

representing an ideal benzenoid tar.

The extreme suggestiveness of this work, both from the theoretical and commercial point of view, will be at once apparent as offering a method by which the least valuable fractions of tar and crude oil can be converted into those for which there is a greater demand.

SERVI SERVORUM DEI.

IT is not only His Holiness the Pope who is *servant of God's servants*; the title well becomes all who are saving or safeguarding the health of the British Expeditionary Force. To read the medical and surgical history of past wars —the American Civil War, or the Crimea, or the Franco-German War—is more pain than pleasure. To read what our Army Medical Service is doing now—a Committee has just been appointed for the writing of this history—will be not the least of the pleasures of peace. We have a foretaste of it, in the article which was published in the daily papers last week, by "an Eye-Witness present with general headquarters." He says, to begin with, that a war such as this, with so much hardship and exposure, would have cost our nation, a few years ago, an outbreak of disease that would have decimated our forces. He goes on to say that the low sick-rate in the Army to-day is due, partly, to the diligent instruction given of late years to our men in the first principles of health. "In the main, however, it is due to the preventive measures adopted by the medical service." And these preventive measures are of two kinds: those which prevent infection from gaining access to our men, and those which strengthen our men to withstand infection.

The article is mostly concerned, and no wonder, with typhoid fever. Yet, if we think of single cases, not of masses of cases, the protective treatment against tetanus, surely, is not a less achievement than the protective treatment against

typhoid. Early in the war, the bad news came of many cases of tetanus; the heavily manured soil of France was full of tetanus; the very earth that our men were helping to defend was their enemy. It is a great blessing that a wounded man may indeed be safeguarded, with a dose of anti-tetanic serum, against this disease; and a great blessing that our men now are on soil which is fairly free from it.

But typhoid, after all, is the supreme test of the efficiency of an army medical service. We have learned of late years that the infection may be conveyed by flies, and by clouds of dust; we have learned also the danger of infection from mild, unsuspected cases, and from typhoid-carriers; we have left off thinking that typhoid cannot be spread without the help of a "polluted water supply." The present control of typhoid for our Army in France has been won by the bacteriologists; all honour to them:—

Mobile bacteriological laboratories have been installed expressly for this purpose (the early detection of cases). Each laboratory consists of a motor-lorry fitted with a complete bacteriological equipment, and is in charge of a specially-trained officer, and an attendant of the Royal Army Medical Corps.

Moreover, it is the bacteriologists who discovered the protective treatment against the disease. On March 5 we learned what our Army owes to that treatment. Of fifty deaths from typhoid fever among our men on active service, forty-eight had occurred among the non-protected, one in a man protected, and one in a man partly protected. Nobody in his proper senses can doubt that Nature finds it easier to kill the non-protected than to kill the protected.

It must not be forgotten that by far the most potent weapon in our armoury against typhoid fever has been forged by pathologists, before the war. Inoculation is the surest defence: and to its extensive use must chiefly be attributed the low incidence of this terrible disease in the British Army.

But the whole article ought to be read carefully, not in fragments.

Doubtless, when the hot weather comes, the work of safeguarding the Army's health will be no less arduous than it is now. For the present, let us be thankful for the splendid services rendered by men of science to our defenders, through all the bitter hardship and perils of the past nine months. STEPHEN PAGET.

THE USE OF ASPHYXIANTS IN WARFARE.

THE use of asphyxiating gases by the Germans in forcing back the French lines to the north of Ypres has given rise to much conjecture as to the nature of the gases employed, and in a long article in a Sunday paper it is surmised that the gas used was carbon monoxide. The only foundation that can exist for such an opinion is that carbon monoxide is one of the most virulent gaseous poisons known, and that less than 1 per cent. in air rapidly proves fatal, but inasmuch as all the explosives in general use produce it in large quantities, the smokeless powders in use by England, France, and Germany, giving approximately 50 per cent. of the permanent gases formed as carbon monoxide, it is hard to believe that the enormous volume produced by firing the charge in the gun should have no deleterious effect on those using it, whilst the much smaller quantity given on the bursting of the shell should asphyxiate the enemy. The fact is, that carbon monoxide is slightly lighter than air, and when driven out by the explosion in a heated condition diffuses upwards so rapidly that scarcely a trace can be found at the breathing level, but when evolved underground in a confined space many accidents have been caused by its poisonous properties.

Moreover, carbon monoxide is in no sense of the word an asphyxiant, and one of its greatest dangers lies in the fact that air containing a poisonous amount can be readily breathed.

Later reports received on Monday and Tuesday make it evident that it was a true asphyxiant, such as sulphur dioxide, chlorine, or a mixture of the two that was employed, and that the fumes generated in front of the German trenches were borne down by a northerly wind upon the Allies. Some descriptions speak of the burning of some substance which gave a yellowish smoke and gases; others that the gases were contained in steel cylinders, the gases being conducted by hose-pipes some little distance in front of the trenches, whilst the men manipulating the cylinders wore divers' helmets, and the first German troops to charge over the gassed area wore smoke helmets or respirators. It is further probable that some shells containing a liquid giving gases of an asphyxiating character were also employed.

It seems to be clear from various descriptions that the gases floated close to the ground for a considerable distance, producing an effect of asphyxiation, which was felt as far as the Allies' second lines.

Both sulphur dioxide and chlorine would have produced the effects described, and the cylinders spoken of might have contained these gases in a liquefied form, whilst it is probable that shells used for asphyxiating purposes would be charged with chloride of sulphur which would itself decompose in moist air or in contact with water into sulphur dioxide, hydrochloric acid, and sulphur, or, if fired by the bursting of the shell, would give sulphur dioxide and chlorine.

Both sulphur dioxide and chlorine satisfy the requirements of being more than double the weight of air, and so might remain near the ground, diffusion being only slow, but it is difficult to understand how sufficient quantities of either gas were produced to render the air irrespirable at the distance of the Allies' lines from the German trenches.

RICHARD LYDEKKER, F.R.S.

BOTH zoologists and geologists lament the death on April 16 of Mr. Richard Lydekker, who had been for more than thirty years one of the most active workers in the natural history sciences. Born in 1849, of Dutch descent, he was educated at Cambridge, where he graduated

in 1871, and was placed second in the first class of the Natural Science Tripos. Joining the Geological Survey of India in 1874, he began his scientific career in the mountains of Kashmir, of which he made a successful pioneer geological exploration. While there his opportunities for sport continued to foster his interest in zoology, and he soon acquired a good knowledge of the mammals and birds of the country. The great collection of Tertiary mammalian remains in the Indian Museum at Calcutta then attracted his attention, and he began a systematic study of these fossils, which he described in the *Palaeontologia Indica*.

With little material for comparison in India, and needing the corresponding collections in the British Museum for reference, Mr. Lydekker soon recognised the necessity of returning to London if his work was to be exhaustive. He accordingly retired from the Indian Survey in 1882, had the fossils from Calcutta sent in instalments to London, and by 1887 had completed the fine series of volumes describing not only the Siwalik Vertebrata, but also the pre-Tertiary Vertebrata of India. At the same time, between 1885 and 1887, Mr. Lydekker prepared for the British Museum a catalogue of the fossil mammals in the department of geology (in five parts), which was followed by similar catalogues of the fossil reptiles and amphibians (four parts, 1888–90), and fossil birds (one part, 1891). Though presenting only a somewhat hasty and superficial view of the subject, these catalogues were at the time of real utility; and they are noteworthy as the first systematic attempt to correlate the European with the more recently discovered American fossils.

In 1893, and again in 1894, Mr. Lydekker visited the Argentine Republic and spent some months in studying the wonderful collection of fossil vertebrates in the La Plata Museum. His work was published in two handsomely illustrated volumes ("Anales del Museo de La Plata," tomos II., III.), and gave the first satisfactory account of several of the peculiar extinct vertebrates of South America. His descriptions of ancestral Cetacea from the Tertiary, and Dinosaurian remains from the Cretaceous, formations are especially valuable. The visits to South America led Mr. Lydekker to appreciate more thoroughly the need for considering the evidence of fossils when dealing with questions of geographical distribution, and in 1896 he published a "Geographical History of Mammals," which is in many respects his most original and important work.

While occupied with purely scientific research, Mr. Lydekker did not overlook the needs of ordinary students, amateurs, and sportsmen, and during his later years most of his numerous writings were adapted for their use. So long ago as 1889 he contributed the volume on vertebrates to the third edition of Nicholson's "Manual of Palæontology," and in 1891 he co-operated with Sir William Flower in "An Introduction to the Study of Mammals." Between 1893 and 1896 he also edited the "Royal Natural History," and wrote the section on vertebrata. Work of this kind was facilitated by his occupation at the British Museum in arranging the exhibited collections of mammals and reptiles in the department of zoology, where he was employed from 1896 until the time of his death. He not only arranged the collections in an admirable manner, but also prepared several valuable guide-books. His last work was a catalogue of Ungulate mammals in the British Museum, of which three parts were published, and the fourth, completing the Artiodactyla, was left by him nearly ready for issue.

Mr. Lydekker was elected a Fellow of the Royal Society in 1894, and was awarded the Lyell Medal by the Geological Society in 1902.

DR. W. J. SELL, F.R.S.

WILLIAM JAMES SELL, university lecturer and senior demonstrator in chemistry at the University of Cambridge, died at Cambridge after a long illness on March 7. He was born at Cambridge in 1847, and for more than fifty years was connected with the chemical laboratories there, and contributed in no small degree to their development and success. He was barely fifteen when, on the recommendation of the master of the elementary school which he attended, he was employed at the chemical laboratory of St. John's College, at that time the only one in the University open to undergraduates. Here he learnt elementary analysis and the use of apparatus, heard the professor's lectures, and saw his experiments. He made good use of his opportunities, and soon made himself an efficient assistant. In 1865, when the Jacksonian professor of natural philosophy removed his apparatus into a new building, the room vacated by him was united with that of the professor of chemistry, and a room built above them for a students' laboratory, the first step taken by the University, in its corporate capacity as distinct from the colleges, to provide experimental training for its students. Here Sell was appointed attendant, and had charge of the apparatus, and not only assisted the professor in the experiments at his lectures, which at that time embraced physics as well as chemistry proper, but was much in demand to help the students, whose notions of making experiments were often crude. The laboratory was a poor place at best in comparison with modern laboratories, but it grew and became filled with students, to which result Sell's help contributed not a little.

In 1870 Sell married, and soon after entered Christ's College and matriculated in the University. He had acquired a good knowledge of chemistry, and of some other branches of natural science, and knew a little of modern languages, but no degree could be obtained at Cambridge without some acquaintance with Latin and Greek, and he had not learnt either. It was a formidable task to begin now, but he faced it with his usual quiet determination, studying Latin and Greek at all times when his duties at the labora-

tory permitted, passed the examination in both languages, and was then able to take the Natural Sciences Tripos for his B.A. degree. In this he obtained a first class in honours for chemistry in 1876. This success brought him private pupils, and therewith an increased income, very necessary for him because University posts were all meagrely paid; at the same time he took a demonstratorship instead of remaining assistant to the professor. A short time afterwards he succeeded to the place of principal demonstrator.

Although Sell's position in the University, thenceforward to the end of his life, was that of a demonstrator, it must not be supposed that his public teaching was confined to what is usually known as demonstrating, which is mainly done by the junior members of the staff. On the contrary, inasmuch as chemical science was constantly expanding and learners increasing in number, the lectures had to be more specialised and the classes subdivided. The University had not the means to multiply the professors, and so the staff of the laboratory had to meet the demand for more instruction as best they could amongst themselves. In this Sell was most serviceable. He shirked nothing so that the teaching might, so far as lay in his power, keep pace with the growth of knowledge, and for many years was in reality an effective professor, though in name only demonstrator. He was never what is called a brilliant lecturer, but was a sound teacher, who gained the confidence of his hearers, and attracted them by his painstaking sincerity and willingness to help anyone in difficulty.

Sell had been elected a Fellow of the Royal Society of London in 1900, and took the degree of Sc.D. at Cambridge in 1906. An attempt was made to get him promoted to the rank of reader in chemistry. The University has full power to do that, and there were similar applications in connection with other branches of learning, and Sell's friends thought that his distinction as a chemist, and his long and faithful devotion to the service of the University, gave him a claim to promotion at that time before any other aspirant to the same rank. The appointment of readers, however, does not rest with the University at large, but with a board composed of representatives of the various departments of knowledge, literary as well as scientific—in fact, with a body of specialists chosen as such. As always happens in such cases, every member of the board thinks that his foremost duty is to see that his own particular subject of study gets its share of money and places, and magnifies it accordingly, so that the board scarcely ever pulls together for the general advantage, still less to do justice to an individual. No readership was created at that time, and all the recognition Sell got was his appointment to a University lectureship with a stipend of 50*l.* a year.

In his younger days, when it was as much as he could do to maintain his family, he could scarcely spare time for original investigations; but later, when the laboratory was grown up and needed less nursing, he was able to show that he had the capacity for successful research and the will to advance knowledge himself, quite as much as to put others in the way of doing it. He will be best known by his work on pyridine derivatives, to which he was led by previous studies of citrazinic acid. These were the subjects of a large number of communications to the Chemical Society from 1892 onwards. In some of these researches he was assisted by one or other of the advanced students in the laboratory, while in other cases he worked alone. Without going into details, it may be mentioned that from pyridine he obtained eight distinct chloro-derivatives, and from pyridine hydrochloride, in addition, some remarkable dipyridyl compounds. Moreover, he did not fail to demonstrate the chemical constitution of most of the new compounds he discovered. Other subjects of interest investigated by him were the salts of a base containing chromium and urea, and colloid solutions of phosphates. All he did bore the stamp of careful accuracy, and he impressed on his pupils the necessity for sparing no pains to ensure this, if any real advance of knowledge were to be made.

He was so unassuming that only those who had known him long found how much was hidden under that modest behaviour. It really meant that he wished always to do what was right, whether convenient or inconvenient, and to believe other people to be as good as himself.

NOTES.

DR. H. KAMERLINGH ONNES, professor of experimental physics in the University of Leyden, has been awarded the Franklin medal of the Franklin Institute of Philadelphia.

IN spite of the war, the usual Dutch biennial congress of Science and Medicine was held this year, at Amsterdam, the first day being April 8. In 1917 the congress will meet at the Hague.

DR. J. ALEXANDER MURRAY has been appointed general superintendent of the Imperial Cancer Research Fund, and director of the laboratories, in succession to Dr. E. F. Bashford.

THE Meteorological Office announces that Mr. J. E. Cullum retires from the post of superintendent of the Valencia Observatory, Cahirciveen, Co. Kerry, Ireland, and that Mr. L. H. G. Dines has been appointed to succeed him, as from May 1. Mr. A. H. R. Goldie has been promoted senior professional assistant in succession to Mr. Dines at the observatory at Eskdalemuir.

AT the beginning of the war the Meteorological Office ceased the issue of weather charts to the newspapers. Announcement is now made that from May 1 the weather forecasts from the Meteorological Office for the several districts of the British Isles will not be available for publication. The only forecasts issued will be in what is known as the harvest weather forecast service. These are entirely local in character, and are telegraphed to agriculturists upon payment of the cost of the telegrams.

THE Civil Service Estimates for the year ending March 31, 1916, recently issued, contain various particulars with regard to the sums to be voted for carrying out the provisions of the National Insurance Act. The grant in aid of medical research, to be paid to the Medical Research Fund, is 56,500*l.*, which is the same as for the last financial year. The grant to pathological laboratories to assist in the provision of laboratory facilities with a view to the prevention, diagnosis, and treatment of disease is 25,000*l.*, which is only half that voted for the financial year 1914–15. The sums voted for sanatorium benefit and for the remuneration of panel practitioners remain the same as before.

FOR the meeting of the British Association to be held at Manchester on September 7–11, under the presidency of Prof. Arthur Schuster, Sec.R.S., the following sectional presidents have been appointed:—Section A (Mathematics and Physics), Sir F. W. Dyson; B (Chemistry), Prof. H. B. Baker; C (Geology), Prof. Grenville Cole; D (Zoology), Prof. E. A. Minchin; E (Geography), Captain H. G. Lyons; F (Economics), Dr. W. R. Scott; G (Engineering), Dr. H. S. Hele-Shaw; H (Anthropology), Dr. C. G. Seligman; I (Physiology), Prof. W. M. Bayliss; K (Botany), Prof. W. H. Lang; L (Education), Mrs. Henry Sidgwick; M (Agriculture), Mr R. H. Rew. Evening discourses will be delivered by Mr. H. W. T. Wager on the behaviour of plants in response to light, and by Dr. R. A. Sampson, Astronomer Royal for Scotland.

A MONUMENT to the late Prof. J. H. van't Hoff was unveiled at Rotterdam on April 17. It consists of a bronze statue, double life-size, in sitting position, and has been placed in front of the school at which Prof. van't Hoff was educated. The monument is about 30 ft. high, and the statue itself is flanked by female figures representing "Imagination" and "Reason." On the front of the base is the following inscription:—

VAN'T HOFF,
1852–1911.
Physicam chemiae adiunxit.

The principal speaker at the ceremony was Prof. A. F. Holleman, of Amsterdam, who directed attention to the fact that owing to the war no foreign delegates were present, and that the proceedings in memory of an international investigator were entirely national in character.

IT is announced that a committee, under the presidency of the Director-General, Army Medical Service, has been formed to provide the necessary co-ordinating authority for the compilation of an adequate medical history of the war. In connection with each of the chief subdivisions of the work, military and civilian members have been appointed, except in the case of the Section of Hygiene, in which both members are military. The constitution of the committee under the presidency of the Director-General is as follows:—*Medicine*.—Lieut.-Col. O. L. Robinson, R.A.M.C., and Sir William Osler, Bart. *Surgery*.—Lieut.-Col. E. M. Pilcher, D.S.O., R.A.M.C., and Col. F. F. Burghard. *Pathology and Bacteriology*.—Sir William Leishman, C.B., and Capt. F. W. Andrewes. *Statistics*.—Lieut.-Col. H. P. W. Barrow, R.A.M.C., Dr. John Brownlee, and Lieut.-Col. W. N. Barron, M.V.O., R.A.M.C. *Hygiene and Sanitation*.—Col. W. H. Horrocks, K.H.S., and Lieut.-Col. W. W. O. Beveridge, D.S.O., R.A.M.C. *Historical and Secretarial*.—Capt. F. S. Brereton, R.A.M.C., and Dr. W. M. Fletcher. In each section the members of the committee have been given authority to co-opt for the purposes of the section other persons, and it is hoped that in the various sections the best results of the varied experience now being gained will be selected and arranged for publication in the Medical History, and not left to be distributed in scattered communications published independently by individual observers.

THE current issue of the *Quarterly Review* publishes a symposium on German "Kultur," and one of the four contributions is by Sir William Ramsay, K.C.B., who deals with the subject as illustrated by German science. He institutes an inquiry as to what share Germans have had in scientific discovery and invention and utilises the data found in "400 Jahre Pionier-Arbeit in den exacten Wissenschaften," by L. Darmstaedter and R. du Bois-Reymond, published in 1904. Between the years 1500 and 1600, out of a total of 176 names mentioned, 39 are German, or 22 per cent. Between 1600 and 1700, out of 312 entries, 48 are German, or 15 per cent. During the next century, the entries are 517, of which 72, or 14 per cent., refer to German discoveries. The period from 1800 to 1850 comprises 901 entries; of these Germans and Austrians form 234, or nearly 26 per cent. Between 1850 and 1900 the records comprise 1021 entries, of which 477, or 46 per cent., can be ascribed to Teutonic sources, but, as Sir William Ramsay points out, it should be remembered in connection with the large percentage of German names in the list that it was compiled by two German savants. The awards of the Nobel prizes are also summarised. "The awards of the Swedish Nobel Committee are unbiassed by any national spirit; four prizes of the approximate value of 8000*l.* are distributed annually, one for physics, one for chemistry, one for medicine, and one for literature. During the twelve years from 1901 to 1912 inclusive, 58 have been awarded, of which 17, or nearly 30 per cent., were received by Germans or Austrians." Similarly the ratio of German and Austrian foreign members and associates of the principal academies of the world is 28 per cent.

ON April 20 Prof. H. E. Armstrong opened at Cardiff a conference on the extension of British trade, which had been arranged by the city's Technical Schools Committee and Development Committee. Prof. Armstrong, in his address, which is reported in the *Morning Post* of April 21, pointed out that there is at the present moment much fiery talk of capturing the enemy's trade, but that in view of its many defects an urgent need will be to develop and improve our own trade, and to preserve it from the attacks to which it will be subject, not only by our present foes, but by our Allies and the Americans. To ensure future progress, the general average of intelligence must be raised in the schools, receptivity and plasticity of mind, and some measure of alertness must be

cultivated in the students. In addition to English and French, Spanish and Russian should be taught in place of Latin and Greek; for men will be needed to go out and discover exactly what is wanted in the countries which, after the war, will be opened to our trade. These men must be able to talk the language of the people whom they are seeking to make their clients. The proper use of coal is, in the future, one of the great problems which we have to face. No bituminous coal should be used directly as fuel; it should be first converted at least into soft coke, so that the ammonia and tar, which are ordinarily wasted, may be recovered and utilised. This is a duty we owe to ourselves and to posterity on economic grounds, as well as in the interests of agriculture and the internal-combustion industry in particular. Our future success as a nation will depend on the fruitfulness of our scientific research. The possession of enormous organisations such as they have in the great chemical works on the Rhine gives the Germans very great power. They do not hesitate to expend vast sums of money in research; they do not think in niggardly terms—as our Government has done within the past few weeks—of 10,000*l.* a year, but without hesitation spend 50,000*l.* a year on a single problem. Thanks to our schools and universities, not forgetting the Civil Service examiners, the ignorance of our commercial community on all matters scientific is lamentable in the extreme; whilst owing to a literary test only being applied, a specially unpractical type of mind has been selected during generations to administer our public affairs.

ALTHOUGH the wrought flints found in great numbers in Egypt have been discussed in various isolated papers, no detailed survey of them has as yet been accessible to students. This want is now being supplied by Prof. Petrie in the first part of an elaborate survey of the subject in *Ancient Egypt*, part ii., for 1915. Flint-working, he points out, began in archaic times, and gradually blossomed out into the grand style of the splendid forms characteristic of the Chellean and Achulean periods, which no later work has surpassed. The Mousterian and Aurignacian ages reflect the decadence of European man in the third glacial period. In this paper the Egyptian and European forms of implements are carefully and with abundant illustrations correlated. This survey, when complete, will be of great value to students of prehistoric antiquities.

MR. W. CROOKE contributes to part i., vol. xxvi., of *Folk-lore* a paper dealing with the Dasahra, an autumn festival of the Hindus. It is held on or about the autumnal solstice, and thus coincides with the harvesting of the autumn and the sowing of the spring crops. It is hence an important crisis in the life of the farmer, during which it is necessary to control, by means of magical rites, the evil spirits which are active at such seasons. It is also the time when after the close of the rainy season the roads become open, and in older times the warlike classes started on their annual raids. Hence it is regarded as an auspicious time for the commencement of any work of importance. A curious incident in the observances is the release of prisoners or their removal from the capital, lest by virtue of a sort of sympathetic magic the spiritual activities should be trammelled by their bonds or chains. It is thus in its original form a complex of animistic or pre-animistic usages, which have been worked over by Brahmans or courtiers, and have thus become associated with the later Hindu pantheon and with the ceremonial of native courts.

IT has often been noticed that an interval of time, marked off by sounds, appears longer than an equal interval marked off by flashes of light. The illusion has commonly been attributed to the so-called visual after-sensation—the persistence of the effect of light upon the retina. A recent research, carried out in the psychological laboratory of the University of California, and reported in the *Psychological Review* for January, 1915, shows that when the intervals are very short (1 sec. or less) and the stimuli repeated, the rate in the sound-series actually appears quicker, as a rule, than the rate in the light-series, although the two rates are really the same. A sound-rate of 154 taps a minute appeared equal to a light-rate of 128 flashes a minute for one observer, and 134 to 150 flashes for others. The higher the rate and the longer the series, the more marked becomes the illusion. Those exhibit it most who depend either upon "general impression" or upon overt tapping with the hand.

THE presidential address delivered by Prof. Tufts at the joint meeting of the American and Western Philosophical Associations had for its subject "The Ethics of States." The address is published in full in the *Philosophical Review* for March. The lover of paradox, says Prof. Tufts, can find no richer field than that of the ethics of States. "The State hales private persons before its bar if they violate person or property, break contracts, or enslave their fellows; but itself commits homicide and trespass, breaks treaties, and takes possession against their will of the persons and property of multitudes who have done no harm." The article analyses the historical and logical grounds for these paradoxes. Historically, States have been built by two great forces: lust for conquest and desire of gain. America has learnt the dangers implicit in corporations organised for profit when they are not themselves controlled. The evils of present international politics are due, not to too much, but to too little political organisation. Logically, the doctrine of the survival of the fittest should involve the conclusion that everything that exists is good—the victor is always the better, the king on the throne can never do wrong, the martyr on the cross has never been right. On the contrary, the article urges that competition between nations may be just as unfair and just as much in need of higher control as competition between individuals or companies in business. It concludes the present situation is bringing home to all nations the consequences of past political ideals in all their horror; and that the very appeals which both sides make for moral approval are indications of the emergence of a larger and higher international conscience.

THE Ichthyological Laboratory of Astrakhan ascertained the existence of more than sixty representatives of the Caspian fauna in the branches of the lower Volga, some species of Mysidæ occurring at a distance of 180 miles from the sea. A dozen years ago also a number of Caspian forms were found near Saratof by the biological station at that town, and the same forms were found in 1911 by A. Derzhanin in the Volga below Kazan and in the lower Kama, one of which, *Metamysis strauchi*, occurs as far up as Yaroslavl. This is identical with the *M. volgensis* of Tretyakof, to which he assigned an Arctic origin. These Caspian forms Mr. Derzhanin believes to have been left behind on the regression of the Mæotis-Caspian sea (Proceedings of the Naturalists' Society of the University of Kazan, 1912–13).

THE Journal of the Department of Agriculture and Technical Instruction for Ireland (No. 2) contains several papers of general interest. Mr. Falkner C. Mason describes a series of experiments which have been carried out during the past year in the veterinary hygiene division of the Department to ascertain how long an injection of tuberculin will confer upon a tuberculous animal the power of resistance to a second injection. This fact has occasionally been taken advantage of by unprincipled persons for fraudulent purposes. In the paper now referred to the trustworthiness of the test in such circumstances has been studied and methods are suggested to counteract any attempt to render the test abortive. The "Boom in Flax" is dealt with by Mr. A. L. Clark, who gives statistics of the extraordinary advance in the prices of this crop brought about by the war. All past records have been broken; not even during the American Civil War has flax realised so high a price as it is being sold at to-day. Mr. Hunter deals with the question of the improvement of the flax crop by propagation from selected plants, a field of work which apparently offers a very hopeful outlook.

THE history of the plantation rubber industry of the east is given by Mr. T. Petch in the recently issued part of the Annals of the Royal Botanic Gardens, Peradeniya (No. vii. of vol. v.). The story affects Ceylon principally, where the records have on the whole been carefully kept. It is unfortunate that certain gaps in the early history are due to the lack of proper records during Thwaite's directorship. The successful introduction of Hevea is due to Wickham, and possibly also to Cross, through the agency of Kew; a few plants have probably also been derived from those collected by Collins near Para. Much diversity, both in leaf and bark characters, is noticeable among the trees of the plantations, but there appears to be no ground for supposing that the trees in the east differ essentially from those in Brazil from which fine hard Para rubber is obtained. The reports of Wickham and Cross are reprinted, and careful details are given of the distribution of the original trees in and from Ceylon. An account of the plantations in the east generally is also given, and is followed by chapters on tapping experiments, Brazilian methods, etc. The history of the introduction of Ceara and Castilloa in 1876 and of other rubber-yielding plants is also given.

THE Geological Survey of Canada has published as Memoir No. 38, in three cloth-bound volumes, the report of the Chief Astronomer on the North American Cordillera, forty-ninth parallel. The author of this work, Prof. R. D. Daly, acted as geologist to the International Boundary Commission between 1901 and 1906, and the report, circulated in 1915, bears the date 1912 upon its title-pages. The recording of the field-observations in a highly mountainous region was hampered by the absence of large-scale and accurate maps; but coloured geological maps and sections are here published of the whole traverse across British Columbia, from long. 114° W. almost to the coast. Fossiliferous horizons are unfortunately scarce; but the igneous phenomena provided ample material for so keen a worker as Prof. Daly, and have led him to insert as chapter xxiv. an "introduction to the theory of igneous rocks." The possible origin of pre-Cambrian dolomites and limestones by chemical precipitation is discussed with similar breadth of view in chapter xxiii. During hard mountaineering work, the author's mind always sought for explanations, and this adds considerable brightness to his description of the structure of the Rocky Mountains, the Selkirks, and the Cascade Range. An overthrust of forty miles is suggested as one explanation of the grouping of strata in the Clarke Range.

AMONG recent Bulletins of the Commission Géologique de Finlande, H. Hausen issues (No. 31) a study of types of porphyry found in the glacial beds of south-west Finland, and points out that many of these are still of uncertain origin and cannot be used as guides in estimating directions of ice-movement. In No. 32, he utilises well-recognised types of erratics in tracing the spread of glaciers from Fennoscandia into Russia, and shows how the "Baltic ice," moving mainly from north to south, has locally obscured the traces of the earlier and greater glaciation of Russia by ice from the north-west. One of his maps shows interesting features of drumlins near Dorpat, and a lake at the south end of the Gulf of Riga, held up between the ice-front and an abandoned terminal moraine. W. W. Wilkman (No. 33) deals with the later shore-lines in eastern Finland, and indicates wave-like movements of the ground; while the director, J. J. Sederholm, in No. 37, emphasises the influence of fracture-lines in controlling existing features in Fennoscandia. He urges that fracturing and faulting may characterise the cover which conceals folded masses, and that this zone is commonly removed from considerable mountain-chains. Students of igneous contacts and metamorphism will find much to interest them in P. Eskola's detailed memoir (No. 40), written in English, on the Orijärvi region. The alterations undergone by limestones, siliceous "leptites," and basic igneous rocks consist almost uniformly in the introduction of iron and magnesium and the leaching out of lime and alkalies.

THE Canadian Department of Mines continues the issue of its useful publications with the object of

directing attention to the mineral wealth of the Dominion and of assisting all who may be inclined to take part in its development. A compact summary of the subject is to be found in a pamphlet of some eighty pages, "Economic Minerals and Mining Industries of Canada," which has been prepared especially in view of the Panama-Pacific Exposition of San Francisco. It contains indeed no particularly novel features, but brings the subject well up to date. Messrs. H. T. Kalmus and C. Harper have published the second portion of their researches upon cobalt and cobalt alloys, this part dealing more particularly with the physical properties of the metal cobalt. Elaborate tests have been made, and are recorded with much minuteness of detail; it might be suggested that the full plate illustration of the testing machine used in making the tensile tests is decidedly superfluous. An elaborate report is published by L. H. Cole upon gypsum in Canada. From the technical point of view this appears to give all the necessary information, but somewhat more attention might have been devoted to the geological problems involved; thus there is no mention of the accessory minerals, such as the native sulphur and the borates, the existence of which in some of the Nova Scotian gypsum deposits has long been known, and which shed a very interesting light upon the probable mode of origin of these deposits. The third part is also issued of the Report on the building and ornamental stones of Canada, this dealing with the province of Quebec. This report also is very rich in detail, and contains much valuable information; attention may be directed to the beautiful coloured plates illustrating the appearance of some of the more notable of the ornamental stones, which are admirably executed.

IN the Tôhoku Mathematical Journal, vi., 2, 3, Mr. Kichiji Yanagihara, of Sendai, discusses the history of the Pythagorean equation connecting the sides of a right-angled triangle in Japanese mathematics. Methods of obtaining integral solutions of this equation were given by Matsunaga (eighteenth century), Ammei Aida (1747–1817), who gave a table of the first 292 primitive solutions, Shôzô Kikuma, Tanehide Chipa (1830), and Sôhei Kaneko (1845). The theorem of Pythagoras was in constant use in Japanese mathematics, and many wasanists gave their demonstrations in their works, but owing to the lack of systematic establishment of geometry many of their demonstrations are found to resemble that of Bhaskara's "Behold" method in his *Vîja Ganita*.

IT is easily shown that the ordinary linear differential equation of the first order between two variables represents a family of curves such that the tangents at all points having the same abscissa pass through a fixed point on an associated curve S. This method was used by Czuber to obtain an approximate graphical solution of the equation by building up the curve out of consecutive small elements much after the fashion of the common construction for the logarithmic curve. In the Science Reports of Tôhoku Imperial University III., 6, Mr. Tetsuzô Kojima gives a method of obtaining a better approximation than that afforded by the original construction, and further employs graphic methods of a similar character to the approximate solution of certain other first-order equations, including the general equation of the first order and second degree.

THE majority of recent researches on thermal radiation deal exclusively with stationary phenomena such as occur in a field when it has attained a state of constant temperature. In a note communicated to the *Atti dei Lincei*, xxiii, (2), 9, 10, Prof. T. Levi Civita has formulated a scheme applicable to the case of a variable field subject to given arbitrary initial and boundary conditions. The investigation is based on the assumption that energy of radiation is propagated with constant velocity, but that the specific intensity of radiation across any surface is not only a function of the temperature, but depends also on the direction of the surface. This hypothesis is necessary in order to account for the transference of heat from a hot to a cold region, Levi Civita represents this effect by the addition of a term in the expression for the intensity containing as a factor the temperature gradient along the direction of the normal. The analytical work leads to the deduction of an equation closely resembling that applicable to conduction of heat in a variable medium.

THE April number of *Science Progress* contains an article by Mr. F. Hyndman in which the recent work of Prof. Kamerlingh Onnes and his pupils on the high electrical conductivity of metals at very low temperatures is summarised. In the case of mercury the conductivity at 2·5° absolute is 10^{10} times as large as at the freezing point of water, but Ohm's law no longer holds—the electromotive force required to drive the current increases a thousandfold for a 10 per cent. increase in the current. If the metal is tested in a magnetic field a small increase in the field may produce a similar large increase in the resistance. Dr. C. Davison, in another article, points out that increase of seismic disturbances along a geological fault may herald a serious earthquake and that attempts should now be made to foretell earthquakes in this way. In a further article Dr. J. Johnstone shows the uselessness of considering the organism as a thermodynamic mechanism, since it is continually arresting the increase of entropy which goes on in inorganic bodies. In an essay review of mathematical text-books the author directs attention to the need of mathematical books which will help men of science to use mathematics without having to wade through the present-day text-books, which seem only intended for the use of schoolboys and undergraduates.

PUBLICATION No. 9 of the Central Meteorological and Geophysical Institute of Chile consists of a discussion by Dr. Walter Knoche of the Hertzian waves recorded at San Carlos de Ancud in 1913. The wireless apparatus employed gives a continuous record from which the number of Hertzian waves, or atmospherics, can be enumerated. Assuming the apparatus equally sensitive throughout the whole period, and the nature of the atmospherics always the same, the daily and monthly totals show remarkable variability. July had more than 16,900 occurrences, the total for

the year—allowing for failures to register—being about 40,000. One July day is credited with the enormous number of 8604. The winter months—the station is in 41° 52′ S. latitude—showed the largest numbers. No clear connection was established with barometric pressure, temperature, wind, humidity, or cloudiness. Rain fell on almost all the days of greatest frequency; but 107 days of the mid-winter months, May to August, were rainy days, so no inference could be drawn. In winter there seemed a distinct increase of atmospherics on days in which thunder was recorded, but in summer this was not the case. The data, however, as to distant thunderstorms do not seem to have been altogether adequate, owing to paucity of stations. A series of tables shows the number of atmospherics recorded for each hour of each day from April to December. For the first three months of the year only daily totals are given.

THE damage done to telephone systems in the tropics by animal life was mentioned in the course of a paper and discussion published in the last number of the Journal of the Institution of Electrical Engineers. The culprits are of all sizes, from elephants and giraffes down to white ants and spiders. Mr. W. Ll. Preece described how the giraffes in East Africa, when their progress is impeded by a telephone line, have not the sense to draw back or "duck" their heads, but push on and carry the wires with them—and sometimes the poles too. The only wood which is respected by white ants is teak, and instrument cases should be made of this or of metal. A telephone instrument was shown which had been persistently used as a hive by a swarm of "bee-like insects," who entered by the slot for the switch-hook, and formed a comb inside which they re-formed as often as it was cleared away by the engineers. Instruments and also insulators have an attraction for spiders, and are often rendered *hors de combat* by their webs, but apparently they leave glass insulators alone, although much trouble is experienced in this connection with the ordinary porcelain type. The webs get coated with dew, and the insulation resistance is brought down to a few ohms only. Sir John Gavey said that the trouble was not always caused by the spiders building their webs in the insulators themselves, but that, in the Argentine these insects breed in millions in the pampas grass; as soon as they come to life they spin a single web, which the wind carries across the country, and veils of these webs sometimes collect from pole to pole and cover the whole of the wires. Cases of beetles boring holes in lead cable and laying their eggs in them have also been well authenticated, and Mr. J. E. Kingsbury had an instance of moths making their home in a multiple switchboard cable. Finally, owing to the troubles which not infrequently occur in bringing difficult local conditions into line with the requirements of home administration, one speaker said that the engineer in charge ran the risk of becoming a mere "red-tape worm" himself.

A LONG and important paper on the compressive and flexural properties of a series of Scottish building and road stones was presented by Mr. Robert Boyle to the Institution of Engineers and Shipbuilders in Scotland on March 23. Twenty varieties of stone, consisting of 211 specimens, were tested. The principal deductions from the tests on Scottish sandstones are as follows. The average ultimate compressive strength for specimens tested dry, at right angles to the bedding, was 479·4 tons per square foot. The average percentage difference in individual results for compression tests varied from 4·3 to 50·3, with a mean of the averages of 23·2 for sixteen varieties. The average percentage differences in individual results in bending tests were much less than in compression, whether dry or saturated. Plaster of Paris coating appeared to have no effect on the ultimate strength of the stone. The crushing strength, hardness, and specific gravity vary approximately as the lime and magnesia compounds, and the crushing strength and specific gravity as the percentage of iron oxides. The crushing and bending strengths vary directly as the specific gravity. The percentage ratio of absorption of water and the percentage porosity diminish as the specific gravity increases.

Engineering for April 23 gives an account of the Brooks Aqueduct, Alberta, Canada. This aqueduct forms part of the irrigation works of the eastern section; last year construction on this section was completed for the irrigation of 440,000 acres. The aqueduct is the first in which the hydrostatic catenary has been adopted for the shape of the water section; it has a length of 10,500 ft., and a capacity of 900 cu. ft. per second, and is the longest aqueduct yet constructed for carrying such a large quantity of water. The reason for adopting the hydrostatic catenary was that the total fall was limited to 4·85 ft. in 10,000 ft., and that consequently it was necessary to use this head to the very best advantage. The water section chosen is the most suitable, as it gives a maximum hydraulic radius for the given area, and a consequent low friction head. Structurally it is economical, for, when full, the shell is in simple tension and free from bending moments and shears. The idea of using this catenary for the water section is due to Mr. H. B. Muckleston, assistant-chief engineer, and it was adopted after experimenting with a full-sized model.

WE regret that by an accident at the printing office after last week's NATURE had been passed for press, the letter on "The 'Green Ray' at Sunset," appeared on p. 204 without the name of our correspondent, Mr. T. B. Blathwayt.

OUR ASTRONOMICAL COLUMN.

COMET 1915*a* (MELLISH).—The following ephemeris of Mellish's comet (1915*a*) is published in *Astronomische Nachrichten*, No. 4796, and communicated by Dr. J. Fischer-Petersen :—

		R.A. (true) h. m. s.		Dec. (true) ° ′ ″		Mag.
April 30	...	18 43 48	...	−10 44·6	...	7·1
May 2	...	46 54	...	11 56·8		
4	...	50 8	...	13 17·0	...	6·8
6	...	18 53 31	...	−14 46·2		

The comet is still situated in the southern portion of the constellation of Aquila, and lies towards the south-east of the stars 2 and 3 Aquilæ.

A note in the *Astronomische Nachrichten*, No. 4795,

gives some further details about the discovery of this comet. In the Monthly Register of the Society for Practical Astronomy (vol. vii., No. 1, January and February, 1915), Mr. Mellish narrates how he first saw the comet on the morning of February 9. Daylight made it impossible to determine any motion of the object, and he had to wait until the following morning, February 10, before he was able to observe its slow movement, and thus recognise the object as a comet. Its position was R.A. 17h. 2m., and declination +3° 15′. The comet is described as being 3′ in size, bright, and having a very short, fan-shaped tail.

ASTRONOMY AND THE WAR.—A correspondent of the *Morning Post* (April 23), writing from Paris on April 22, relates how astronomy is found among the victims of the war. At Nantes, he relates, "an electric tramway built out to an English camp put all the instruments in the observatory for the registration of terrestrial magnetism out of order, and made observation impossible. The observatory of the Puy de Dôme found itself cut off from the outside world at an altitude of 5000 ft. The funicular on which it depended in time of peace stopped working, and all the horses had been commandeered, so that the astronomers had the choice between leaving their post and being starved. Happily the problem was solved by the artillery depôt of Clermont-Ferrand, which undertook the task of provisioning the observatory."

ELECTRIC FURNACE SPECTRA OF VANADIUM AND CHROMIUM.—The results of some very interesting experiments with regard to the variation with temperature of the electric furnace spectra of vanadium and chromium appear in the current number of the *Astrophysical Journal* (March, vol. xl., No. 2, p. 86), by Dr. A. S. King. The author has been able to record his observations at three separate temperatures, which he denotes as high, medium, and low. The temperatures on which the classification is based were recorded by a Wanner pyrometer, and were 2500–2600° C. for the high, 2300–2350° C. for the medium, and 2000–2150° C. for the low temperature. The metals used were metallic vanadium and crystalline chromium of "fair purity," and the furnace tubes used were of re-graphitised Acheson graphite. The paper gives two tables of the intensities of the lines measured under the three temperatures, together with the arc intensities; several reproductions from the spectra are also included. The conclusions drawn indicate that the spectra of these substances develop similarly to those of iron and titanium, vanadium being very like titanium. The chromium spectrum near the temperature at which the vapour begins to radiate predominates in Class I. lines (lines relatively strong at low temperatures and strengthen slowly at higher temperatures), which change little at higher temperatures. Certain chromium lines, very diffuse in the arc in air, may be resolved into sharp components in a vacuum source, either furnace or arc. A large number of lines belonging to various furnace classes are relatively weak in this arc. The spectrum increases into the utra-violet as the temperature rises. The ability of lines to show self-reversal in the furnace distinctly increases with decreasing wave-length. The absence in the furnace of banded spectra which appear in the arcs of vanadium and chromium indicates that they are probably due to the oxides of the metals.

RECENT PAPERS IN THE "ASTRONOMISCHE NACHRICHTEN."—A large number of the issues of the *Astronomische Nachrichten* came to hand together last week, and while the material included is of too great and varied a nature to be dealt with in this column, it may help readers to know some of the chief contents. For this reason the following curtailed list of communications is given:—No. 4797: Observations of long-period variables (1914), by A. A. Nijland. No. 4796: Observations of the planet Jupiter, by H. E. Lau. No. 4795: Numerical investigations on a class of periodic orbits, by Carl Burran and Elis Strömgren; observations of comet 1913*f* (Delavan), by A. Abetti. No. 4793: The variable star W Cygni, by G. Hornig; Observations of SS=V 19 Cygni, by A. A. Nijland. No. 4792: Tables for the computation of precession for stars near the pole, by L. de Ball; ephemeris of the periodic comet of Tempel 2, Johannes Braae. No. 4791: Determination of the position of third order points on the moon's surface, by K. Graff and W. Voss; observations of the star BD 89·1°, with the large refractor of the Berlin Observatory, by L. Courvoisier. No. 4787: Observations and elements of the Algol star 10, 1914, R. S. Canum Venaticorum, by Cuno Hoffmeister; elements and ephemeris of the periodic comet of Winnecke for the appearance in 1915, by K. Hillebrand. No. 4786: Definite orbit of comet 1890 III., by S. Ogura and H. Kaneko; observations of Algol stars, by R. Lehnert; the orbit of comet 1913*f* (Delavan), by G. van Biesbroeck. The contents of the Nos. 4777 to 4785 will be given next week.

THE "GAZETTE ASTRONOMIQUE."—In this column for December 24 last reference was made to the proposed publishing in this country of the *Gazette Astronomique*, the monthly bulletin of the Antwerp Astronomical Society, should sufficient financial aid be forthcoming. It is satisfactory to be able to record the appearance of the first number, but its continuance will depend on the support given to it in the future. The present issue contains an interesting account in English of the Uccle Observatory under German occupation, a description of a photograph of Delavan's comet, taken by M. G. van Biesbroeck in September last, a series of notes on astronomical current literature, etc. The first number promises well for future issues.

BRITISH GEOLOGY.

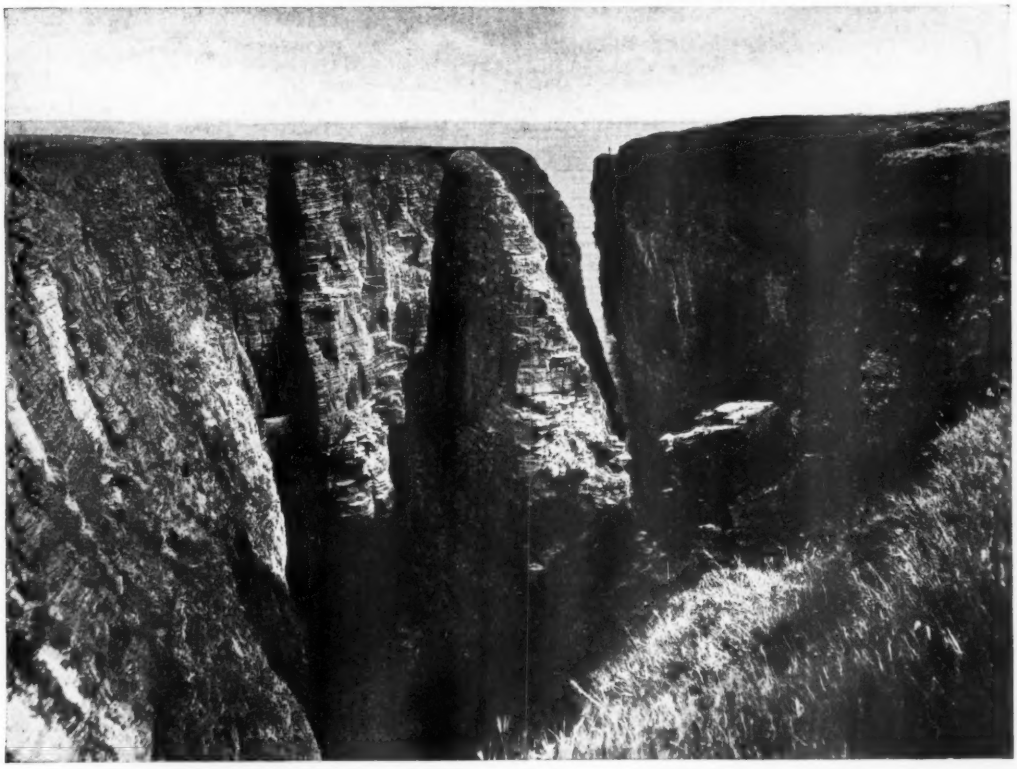
THE series of memoirs published by the Geological Survey of Great Britain on the South Wales Coalfield reaches part xi. in the description of "The Country around Haverfordwest" (1914, price 3*s.* 6*d.*). Dr. Strahan is fortunate in having colleagues who, like himself, have become devoted to this particular ground. The district here described includes a considerable development of the Llandovery series, which is divided into local stages, the lowest of which rests, with an occasional conglomeratic facies (pp. 78 and 201), on rocks of Upper Bala age, while the highest stage laps over on to far older series. The Lower Old Red Sandstone is unconformable with the beds below it, and contains plant-remains, which are unfortunately indeterminable. The structure and economic features of the eastern part of the Pembrokeshire Coalfield are described.

The pre-Glacial wave-cut platform recognised in southern Ireland is shown to exist also at Milford Haven (p. 214). Dr. Strahan (p. 220) points out how the older glacial drift of the area was brought in from the north-west, and even from the west, by a lobe of the Irish Channel ice. Through a recent subsidence, the rock-floors of the valleys tributary to Milford Haven lie far below sea-level, and a submerged forest with flints worked by man, which were recognised by A. L. Leach, occurs at Amroth on Carmarthen Bay.

Memoir No. 83 of the Scottish series (1914, price 2*s.*) deals with "The Country round Beauly and Inverness." The names of J. Horne and B. N. Peach are still to be seen happily associated on its cover,

with those of younger colleagues. One of the most striking features of the district is the Great Glen fault, which, despite its Caledonian trend, is later than some of the folding of the Old Red Sandstone, and has here a minimum throw of 6000 ft. The river-scenery is finely illustrated, and attention is directed (p. 82) to a deep pre-Glacial channel at the mouth of the valley of the Ness, the rock-floor of which has not been reached at 290 ft. below Ordnance datum. The Strathpeffer Spa, with its sulphur-bearing springs, is the main economic feature of the district. In a region so rich in human history, we wish that a geological survey might trench farther on the field of the geographer and the archæologist.

Drs. Peach and Horne have provided a description of the "Geological Model of the Assynt Mountains" very large area. We miss a reference in the memoir to the old tale of the "Caithness grin," which was said to be developed among a hospitable folk by sighting a stranger across miles of level flagstone. The evidence for a Middle Old Red Sandstone Series, which was sustained by J. W. Evans in 1891, is fully substantiated in this memoir, in consequence of the studies made by Traquair on the fossil fishes. These include the interesting Palæospondylus at Achanarras. We should like to have a further account of the flora of the Caithness strata, beyond the brief references on pp. 5 and 81. The successive stages of deposition of the Old Red Sandstone in "Lake Orcadie" are well shown in diagrams on pp. 84 and 85. A downward warping of the Caledonian continental surface allowed of the accumulation, as Sir A. Geikie long ago esti-



Thurso Flags (Upper Caithness Flags) cut by a typical ravine or "goe," south of Duncansby Head. Many of these "goes" are of pre-Glacial origin. Reproduced from the Memoir to Sheets 110 and 116, by permission of the Controller of H.M. Stationery Office.

(1914, price 1*d.*), which is exhibited in the Museum of Practical Geology, the Royal Scottish Museum, Edinburgh, and elsewhere. This modestly priced pamphlet, with its numerous sections, forms an excellent introduction for the student to the classic district of the Highland overthrusts.

The memoir to Sheets 110 and 116, entitled "The Geology of Caithness" (1914, price 4*s.*), is by C. B. Crampton and R. G. Carruthers. The maps (2*s.* 6*d.* each) with the memoir show a thinly populated country formed mainly by Old Red Sandstone, and descending from the Highland region northward, until it becomes, in comparison, a plain with "monadnocks," now stretching at about 150 ft. above the sea. Peat, as the useful system of shading shows us, covers a

mated, of some 16,000 ft. of Caithness flags. The origin of red strata in a warm and fairly dry climate, where vegetation exists, but not in sufficient quantity to acidify the soil, is discussed in chapter ix. The considerable amount of calcium carbonate in the flagstones is attributed to an arid epoch, here called a cycle, affecting the deposits on the shores.

The suggestion (p. 100) of the sudden suffocation of fish by the inflow of alluvium is supported by a recent observation of E. Kolb during his descent of the Arizona canyons. The gills of the fish were, however, in this recent case choked by mud during flooding of the stream, and not in a period of marginal recession.

The nearness of Cretaceous masses to the north-

east coast of Scotland, and the possibility of the existence of outliers beneath the Glacial drift, is shown by the account (p. 131) of the Cretaceous sandstone of Leavad, which was recognised by D. Tait in 1906. This block, 240 yards in length, is used as a sand-quarry, and rests on a green clay which, from its foraminifera, G. W. Lee regards as perhaps of Pliocene age. This in turn rests on boulder-clay, so that, as happens in Ostpreussen (NATURE, vol. lxxxv., p. 470), local geology has been distinctly enriched by material imported during the Ice age.

The Geological Survey states that the issue of some of its colour-printed maps is delayed by work necessitated by the war; but it makes its own contribution to military needs in a pamphlet on "Sources of temporary water supply in the south of England and neighbouring parts of the Continent" (1914, price 2*d*.). The waters of sand-dunes, alluvium, and river-gravels are especially considered, and useful warnings are given as to pollution. It is remarked (p. 10) that a well sunk in sand or gravel on a chalk hill may lose its water if carried down to the surface of the porous chalk.

The proceedings of local societies, especially where universities are at hand to provide a stimulus, afford valuable supplements to the publications of the official surveys. The second part of vol. xv. of the Transactions of the Geological Society of Glasgow (price 7*s*. 6*d*.) forms an admirable example. All the papers record original observations in southern Scotland. Prof. J. W. Gregory (p. 174) treats of the red rocks of the Isle of Arran, which he regards as including Permian desert-beds at Brodick. These terrestrial deposits are, he urges, Lower Permian, and the appearance of conformity with the Keuper Marls above may be deceptive. G. W. Tyrrell (p. 188) describes critical sections in spots which he visited at Prof. Gregory's request, and is unable to discover any break in the sedimentation. The papers by P. Macnair, R. G. Carruthers, and J. E. Richey on the lower beds of the Carboniferous Limestone Series will do much to help workers in other districts, such as the north of Ireland. G. A. J. C.

EXPERIMENTAL BOTANY AT TRINITY COLLEGE, DUBLIN.

IN "Notes from the Botanical School of Trinity College, Dublin," No. 5, vol. ii., 1915, Prof. H. H. Dixon gives experimental proof that morbid changes spread through plants from branches killed by heat. If a portion of a branch be killed by heat and the substances dissolved as the result of the heating be washed away, morbid changes only take place after some fourteen days. In cases where no steps are taken to remove the poisonous substances liberated by the heating, the branches above the heated portion show morbid changes in the course of five days. It is clear from the experiments that with the killing of the cells by heat, substances are liberated into the sap which contaminate the water supply to the living tissues above, and that the morbid changes are not due to the cutting off of the supply of water.

In a further paper in the same number of the "Notes" Prof. Dixon gives the result of his investigations into the nature of the changes which are produced in the sap by the heating of the branches. Sap was extracted by means of a centrifuge from pieces of branches, and was examined both fresh and after steaming for the acidity, colour, presence of oxydases and quantity of dissolved substances. The steamed sap showed marked acidity, a much higher percentage of dissolved substance—indicated by the depression of the freezing point—and a development of colour, any oxydase present being, of course, destroyed. The presence of poisonous properties was proved by placing leaves of *Elodea canadensis* in the steamed and in fresh sap, when it was noticed that lethal effects were produced quickly by the steamed sap, and that the leaves would not recover when placed in water.

In a paper on the tensile strength of sap, Prof. Dixon records tensions of about 207 atmospheres and 132 atmospheres in a tube of sap collected from a branch of *Ilex aquifolium*. The former of these is probably the highest yet recorded for the cohesion of any liquid. The tensile strength of the sap of trees, like that of water, is considerable, but it is probably somewhat more stable under tension than pure water. Prof. Dixon and Miss Marshall have also examined the elements of the wood of trees in relation to the ascent of sap, and find no evidence to support Janse's hypothesis as to the intervention of the living cells in the ascent of sap in stems.

Mr. W. R. G. Atkins publishes a series of careful papers on oxydases and their inhibitors in plant tissues, and his work confirms that of Keeble, Armstrong, and Jones. The distribution of oxydases in the flowers of Iris has been particularly studied; when they are kept in darkness, the quantity of active peroxydases increases. In the Pogoniris group an active peroxydase is absent. The localisation of oxydases and catalases in some marine Algæ has also engaged the attention of the author.

ENGINEERING, EDUCATION, AND RESEARCH.[1]

RESEARCH.—Research for the solution of new problems is of great importance, but it is not a task for young and immature students. Many so-called researches, in which well-understood methods are applied to materials or subjects not themselves important, scarcely deserve the name. They amount to little more than class exercises. Most scientific societies receive papers in which a much over-elaborated description is given of known proceedings and precautions, in which the new results are of limited value without establishing any general law. But the value of real research, based on a clear formulation of a definite unsolved problem, cannot be overestimated.

Unfortunately, in engineering, the solution of unsolved but important problems is generally both difficult and expensive. Much, no doubt, is done by manufacturers who have a financial interest in the work. But their researches are, in general, not fully published. It is of great interest to the public at large and to other engineers that a scientific institution like this feels it part of its duty to advance knowledge by research, and is able to devote a fraction of its income for such researches as are beyond the means of private engineers. In most cases, a research committee of this institution begins by an investigation of what has been done before, and the summary of previous investigations which the institution publishes is not only a safeguard against mere repetition of experiment, but is valuable in itself. Prof. Martens, the director of the great State laboratory at Grosslichterfelde, has said that in four cases out of five when a manufacturer brings him a problem, it is found that it has already been solved somewhere by somebody.

The War and Engineering.—We meet in circumstances not foreseen a year ago. A war of unprecedented magnitude, extending over a vast area, has broken on us with the suddenness and fury of a tropical storm. We are already proud of the courage

[1] From the presidential address delivered to the Institution of Mechanical Engineers on April 16 by Dr. W. Cawthorne Unwin, F.R.S.

and military skill of our Army, the magnificent work of the Navy, and the resource of the Government in meeting extraordinary emergencies. As engineers, we know that our dockyards, arsenals, and armament firms are great schools of technology where the utmost resources of science and experience have been utilised. Victory, if we reach it, as we confidently trust we shall, will largely be the result of the general progress in mechanical engineering and in the capacity of our factories and workshops, due to the concurrent exertions of all engineers, civilian and military.

In this war the question of transport for troops, for munitions, and for food has assumed an importance never experienced before. It is only by the use of every mechanical appliance that a war on the scale of the present one is possible. Conveyance of food, munitions, and troops beyond railheads to the nearest possible point to the firing line depends almost exclusively on motor traction. The vehicles comprise columns of motor-lorries, box-cars, motor-ambulances, motor-omnibuses for troops, motor-cars for officers, steam-tractors for guns and travelling kitchens. It has been necessary to provide large stores of spares and well-furnished repair shops.

I think we may regard the conveyance of the Expeditionary Force as a triumph of organisation. A committee of railway managers, formed before the war, had studied the necessary arrangements. Three hundred and fifty trains were at work, and they arrived at Southampton from all parts of the country, between dusk and dawn, at twelve-minute intervals, during ten days. The troops and their heavy equipment were detrained and embarked without a hitch, and, guarded by the Navy, were transported to Boulogne without molestation.

As engineers, we may recall with pride the words of Mr. Churchill in regard to the ships at the Falkland Islands battle and the cruiser raid. He pointed out that "all of a sudden the greatest trial was demanded of the engines, and they excelled all previous peace time efforts. Can you conceive," he said, "a more remarkable proof of the excellence of British machinery, of the glorious industry of the engine-room branch, or of the admirable system of repairs and refits by which the Grand Fleet is maintained without exhaustion?" In this connection I should like to refer to the reform effected by Lord Fisher, conferring military rank upon the old entry engineers of the Royal Navy. Hitherto, in spite of their invaluable service and the risks they ran, they were rated as civilians. Lord Fisher said that "the unapproached efficiency of the engineers in the Navy merited this tardy recognition of their all-important part in the splendid fighting condition of our whole Fleet."

If in this war the work of the mechanical engineer has assumed a new importance, if success depends on an enormous supply of munitions, if, as Mr. Lloyd George said, "the turning out of munitions of war not merely means success, but means the saving of lives," then a great responsibility is placed on the shoulders of engineers. They are called on for the utmost exertions and perhaps for more sacrifices than others, except those at the front.

Foreign Competition.—Nevertheless a retrospect of our methods and activities is not entirely favourable. *Fas est et ab hoste doceri*, and it is no condonation of the military crime of Germany to recognise that the enormously rapid industrial advance in that country has serious lessons for us. Consider these facts. In sixteen years the aggregate income of Prussia has nearly doubled. While our Mercantile Marine increased from 9 to 10 million tons, that of Germany increased from 1 to 2½ million tons. In 1870 Germany had seven shipyards employing 3000 hands; in 1900 she had thirty-nine shipyards employing 40,000 hands. Although Germany has on the whole poorer qualities of iron ore and coal, her production of pig-iron increased from 11 to 19 million tons annually, while ours increased only from 9 to 11 million tons. To-day her production of steel is nearly twice as great as ours.

Various artificial conditions have fostered German trade, some of which might, and others could not, be imitated with advantage. The German Government is poorer than ours, but it has much more clearly recognised the interdependence of science and industry, and the duty of the State to assist industry in matters beyond private initiative. It has spent very much more in providing the highest type of technical instruction and State research laboratories. The railways and canals being under State control, differential rates can be adopted to help traders. The banks, advised by a staff of scientific, legal, and commercial experts, have been ready to promote the trial of inventions, and to subsidise promising but necessarily speculative industrial undertakings on a scale unknown in this country. Amongst other influences which have adversely affected our manufacturers may be reckoned some perversities of the Patent Law. Hence it has come about that, since the war began, we find ourselves in want of important products we can no longer obtain, and we realise that Germany fights not only with her army, but with her science and industry.

The most striking examples of the plight to which we have been reduced are found in the chemical industries, which, however, involve a good deal of mechanical engineering. Aniline mauve was discovered in this country in 1856, but the Germans, and to a certain extent the Swiss, have practically captured the whole colour industry. Prof. Meldola stated that, in 1886, nine-tenths of the dyeing colours used in this country came from Germany. Yet these are essential to textile industries having an annual output of 200,000,000*l.*, employing 1,500,000 workers. The production of synthetic indigo in Germany has largely destroyed the cultivation of natural indigo in India. The value of imported indigo from India in 1895 was about 3,500,000*l.* At the present time it is about 70,000*l.* Baeyer discovered synthetic indigo in 1880, but nearly twenty years were employed in research and nearly a million pounds was spent before commercial synthetic indigo was placed on the market. That is immensely creditable to German faith in science. Before the war the world's demand for electrical porcelain was practically met by Germany alone. There are many other similar cases. In these industries Germany had no natural advantages, but only a greater scientific intelligence and greater confidence of financiers in supporting scientific advisers.

To take another instance of more interest to engineers. Germany has acquired a practical monopoly of the treatment of the complex ores of the baser metals. The whole of the ores of zinc, lead, and silver from the mines of Australia, the richest in the world, are under contract sent to Germany for reduction. The Australian Attorney-General stated that "German influence exercised a monopoly over the world's base metal industry, so complete that it excluded effective competition."

Happily, in the iron and steel industries we are in a better relative position. Metallurgists here and in Germany, Belgium, and the United States have learned much from each other, and we have no reason for dissatisfaction with our part in the progress made. We had a long lead, and the discoveries of Bessemer, Mushet, William Siemens, Thomas, and Gilchrist, and others kept us in the front rank. We have been outpaced in volume of production, but in the higher qualities of steel and steel alloys, both in investigation and the quality of our product, we still hold a lead.

The large demand for warships, guns, and projectiles has no doubt been a favourable factor. The establishment of laboratories directed by competent experts in steel works and the works of large consumers like the railway companies has tended to the improvement and standardisation of quality.

Nevertheless we do not maintain superiority in all departments. In the heavy steel and machinery trades we have a dominant position, but for lighter machines Germany, the United States, and Scandinavia have secured a large market. In the case of light and medium steel castings—those required for motor-cars, for instance—this country has become almost dependent on Germany and Switzerland. The use of steel castings has very greatly increased, and they add in an important way to engineering resources. So far as a reason can be found for the better and more uniform quality of Continental steel castings, it lies in the adoption abroad of the electrical furnace, and great attention to heat treatment. Many of the steel castings come from Switzerland, where the cost of raw materials must be greater than in this country, and the cost of carriage must balance the lower labour cost.

There is another point. After the war, when happier conditions return, our manufacturers must be willing to give designs, specifications, and estimates in metric measures for countries where the metric system is adopted. The use of the metric system is legalised, but its compulsory adoption is not likely to be enacted, at any rate for a considerable time, if indeed it is desirable, about which a good many of us have doubts. Meanwhile, in many branches the use of a double system of metric and English measures involves little difficulty. In fine machinery no doubt it is troublesome, but that at present must be faced.

Technical Education.—Samuel Butler said that life is the art of drawing sufficient conclusions from insufficient premises. It is certainly true of the engineer, not engaged in mere repetition work, that he has constantly to arrive at conclusions and to act on insufficient data. Probably no difficult engineering problem has ever in the strict sense been completely solved. The engineer has to make assumptions, to use approximate theories, to decide between material and negligible considerations, and to allow for unknown contingencies. Now, scientific training, if sufficiently advanced, does enable us to solve most problems which are clearly stated and data given, but its usefulness does not end there. The trained engineer with incomplete data reasons correctly, estimates probabilities, and knows the limit of the trustworthiness of his conclusions. He does not snatch at a pocket-book rule and ignore the assumptions on which it is founded.

Among the various causes which have contributed to German industrial development, a thorough and widely diffused technical education must be given an important place. The branches of industry in which Germany has acquired a dominant position are those in which advanced applications of science are most necessary.

In the highest branches of scientific discovery this country has held a very distinguished place. That has been largely due to men who pursued science without regard to any practical end, or even with a certain disrespect for the fruitful applications of science. The value of this pursuit of pure science is, of course, not to be underrated. Manufacturers, on the other hand, who are interested only in applications of science, have been a little contemptuous of scientific men who seemed indifferent to business. All that is no doubt gradually changing. The means of obtaining technical knowledge, and the desire to take advantage of it, have increased. But even yet we have no institutions quite equivalent in buildings, equipment, and staff to the great technical high schools on the Continent. In Germany and Austria, excluding chemists, there are four or five times as many students in technical high schools as in colleges of corresponding rank in Great Britain. America, Belgium, and Switzerland in this respect have closely followed Germany.

But now, putting aside political and moral considerations, it is the thorough and advanced character of the education in the technical high schools and the researches of their professors, to which indeed many of us are greatly indebted, which have so directly promoted German industry. It is sometimes said that the Germans only pick up other people's discoveries and apply them. I think that is untrue, or at least greatly exaggerated. As Dr. Ormandy has well said, "those who adapt scientific discoveries to industrial use are as entitled to honour and reward as those who made the original discovery." But there is another aspect of education in Germany which has a lesson for us—the German secondary school is far more efficient than ours. Lord Haldane said that "in this country we have never understood the significance of the secondary school. In Germany the whole educational fabric rested on it." Secondary education in Germany is State-supported and definitely graded. The Gymnasium, the Real-Gymnasium, and the Real-Schule are organised to meet the wants of boys intended for different careers. Further, the universities, the professions, and higher Government appointments (including those on railways) are practically closed to all who do not pass a severe State maturity examination after nine years' schooling. The precise arrangements differ in various States, but in each there is an organised system and great pressure on boys to reach a high standard. Also those who pass the maturity examination are excused one year's military service. The importance of that for us is that a great obstacle to really efficient technical instruction in this country is the inadequate preparation for it in the schools. Practically a year of the three years' college course must be given to work which could well be, and ought to be, acquired in school by lads of seventeen or eighteen. Perhaps the excessive attention to athletics has something to do with our intellectual shortcomings.

I have spoken of the value of an advanced type of technical education for engineers who aspire to positions of responsibility, but I do not overlook or underrate the necessity of practical experience. Both are necessary, but one should not be cut down at the expense of the other. There are many branches of engineering, and as to the relative importance of technical instruction, workshop, field, and office training, in different cases, there may be differences of opinion. Further, I am far from advocating the Germanisation of English education. Only it seems to me that some of our educational tools, like some of our workshop tools, are medieval and out of date, and that some of our faults need a remedy. If, as I suppose, the cost of the war must be paid out of the profits of industry, it is of importance that our efficiency should be increased. Sir George Reid has said that "captures of German trade in time of war will only be retained in time of peace by the capture also of the scientific methods of the Germans."

Testing Materials.—Half a century ago, most materials of construction were selected and bought on the reputation of the manufacturer. Experience roughly indicated the sources from which the most trustworthy supplies could be obtained. Now scarcely any material in large use is accepted without special testing in the interest of the purchaser. Such testing is primarily intended to distinguish suitable and unsuitable mate-

rial and to protect the user from carelessness or fraud. But it has also acted as a stimulus to manufacturers to standardise and improve their products. Once it is known how good a quality can be produced, all manufacturers strive to reach it, and the average quality is raised. The rapid development of cement and of the higher qualities of steel has depended on the determination of their superiority by accurate tests in the properties required for special services.

With the introduction of mild steel, the quality of which ranges between wide limits, the need of systematic testing became urgent. Now there are testing laboratories in the works of most railway companies and in steel works. Also the practice of testing has been adopted in the case of many other materials. With the extension of testing has come the need of standardising tests themselves, a work now largely accomplished by the International Association and the British Standards Committee. But with the increasing stringency of specifications, perhaps more attention should be given to the calibration of the instruments used in testing. In physical investigations great attention is given to the determination of the errors of instruments and methods, and perhaps in material testing this has received too little attention. I do not suppose there are important errors in the indications of large testing machines, though a comparison of results in different laboratories would be interesting. Errors in subsidiary apparatus are probably more frequent. It is possible with a standard bar and a good extensometer, used by the same practised observer to measure the agreement or disagreement of different testing machines. I have found also the use of copper cylinders subjected to crushing to be a very convenient means of checking load indications of machines.

On the Continent and in the United States there are public laboratories, supported by the State, where anyone can have tests made, at moderate fixed rates, by a trained scientific staff and with great accuracy. Such institutions assist industry if, on one hand, they meet industrial requirements, and, on the other, are unbiassed by private interests. They have the advantage over private laboratories that they are under the direction of experts of exceptional experience and reputation, and are able to pursue investigation, continued often for long periods, beyond immediate requirements into fruitful by-paths. The view taken in Germany is that the work accomplished is partly of advantage to the manufacturer who calls for assistance, and so far should be paid for by him, and partly is of advantage to the nation in advancing science, which is the justification for a State subsidy. Hence it is incumbent on the public institution to publish results as freely as is possible without injuring private interests.

At Grosslichterfelde the annual income from fees for testing amounts to 20,000*l*., and the annual State subsidy is 12,000*l*. On the staff there are 230 persons, of whom seventy-five have had university training and thirty-eight technical high-school training. Since 1880 the work accomplished has steadily and regularly increased.

The Bureau of Standards at Washington is on a still larger scale, and does very similar work. It receives an annual subsidy from the Federal Government of 100,000*l*. The equipment is extraordinarily complete. For instance, it has a 600-ton testing machine at Washington, and a 1000-ton testing machine at Pittsburgh, both of the highest sensitiveness and accuracy. Such machines do not exist in this country. Happily, we have now a similar institution in the National Physical Laboratory at Teddington. Its functions are somewhat restricted by the characteristic English jealousy of State action, which I think is diminishing. It would be difficult to overestimate the service it has done in the solution of various mechanical, electrical, and physical problems which were unlikely to be attacked by private persons. Some of the researches started by this institution have been carried out there, and valuable papers contributed to our Proceedings. The superiority of English aeroplanes has been demonstrated, and their services for scouting and for directing artillery fire have been invaluable. When the Government required difficult experimental investigations to be carried out on aeroplanes, it found at Teddington a staff and an organisation already in existence and suited to the purpose.

It is a condition of commercial testing that the results should be available in a short time and at small expense. Hence ordinary tests are of a somewhat arbitrary character, and do not completely imitate the conditions of actual service. We test specimens of steel to destruction and measure ductility by plastic deformation, though in use the stresses do not exceed the elastic limit and the deformation is elastic. We test cement in tension and use it in compression. There is need for constant criticism of methods of testing and for the invention of new tests, such as tests for hardness and brittleness, although new tests must be cautiously introduced.

One small change could be easily made, and in some cases would be interesting. When a set of tests on a material has been made, the mean of the results is taken as the best value of the property measured. In physical investigations generally a further step is taken by calculating what is termed the "probable error," which broadly is a measure of the trustworthiness of the results. Calculation of the probable error is troublesome, but Martens has pointed out that the "mean error" is nearly as accurate, and good enough for practical purposes. The mean error is the sum of the deviations of the individual results from the mean, irrespective of sign, divided by the number of observations. The mean error is conveniently expressed as a percentage of the mean value. If the mean error is large, either the method of testing, the uniformity of the material, or the preparation of the test specimens is at fault. Generally the source of the error can be inferred. A large mean error in tests of steel would indicate want of uniform quality in the material, in cement—probably faults in preparing the test briquettes. Of two supplies of a material, that with the smallest mean error is preferable.

There is another kind of testing, likely in the future to be of increasing importance—that is, the measurement of strains in members of completed structures in order to determine the stresses to which they are actually subjected in service. Some years ago, after the loss of the *Viper*, measurements of the strains in the skin of a torpedo-boat slung in various ways were made at the request of the Admiralty. The object was to obtain information on the stresses in a structure supported on waves. Strain measurements on the members of bridges during the passage of trains have been made in Holland, in France, by Mr. La Touche and Mr. Sales in India, and by Prof. Turneaure in the United States. These observations throw light on two points—the trustworthiness of theoretical calculations of the stresses and the magnitude of the stresses due to dynamical actions which cannot be calculated. Recently Mr. I. E. Howard, engineer-physicist at the Bureau of Standards, has initiated a very extensive investigation which is to extend to large bridges, the Panama lock-gates, and steel-framed buildings. Some results on the stresses in the shell of a simple cylindrical tubular boiler have been published. A cylindrical boiler shell is a very simple structure, and the straining

action is statical. It might be expected that theoretical calculations of the stresses would in that case be approximately verified by the observations. In fact it is not so. The distribution of stress is very much less uniform than it is assumed to be in theory and in the design of boilers. Of course, this is chiefly due to angle-irons and joints, which in most cases reduce the stresses, but, at any rate, greatly modify the stress distribution.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—The course of instruction in engineering for the B.Sc. degree is conducted upon the "sandwich" system. Under this plan, the laboratory staff is occupied during the six winter months in providing the prescribed lectures and demonstrations for the students. During the months April to October the ordinary students obtain their practical training as pupils in the various engineering works of the district. In summer the laboratories are accordingly employed only for special forms of instruction and for research. This year, at the close of the winter session, Prof. Cormack and his colleagues—lecturers, assistants, demonstrators, and mechanics—offered their services through the principal of the University to Lord Kitchener for any purpose connected with the production of munitions of war, which he might think fit to indicate. The Secretary of State, through the Master-General of the Ordnance, has cordially acknowledged the offer of the staff, and promises speedily to inform the University as to the manner in which it may be utilised to the best advantage. In the meantime, the Admiralty has, with the sanction of the University Court, made arrangements for using the equipment of the laboratories, and in particular of the testing machinery, for the purpose of testing the specimens of steel and other metals employed by the contracting firms who are manufacturing shells, etc. Prof. Cormack and Mr. Morley, lecturer on heat engines, have undertaken to supervise the operations under the direction of the Admiralty inspector. A large proportion of the engineering students, who completed their course at the graduation in April, have found places in the munition factories.

LONDON.—Among the public lectures, which are open to the public without fee, to be delivered at University College, during the present term, are the following:—April 29: Prehistoric Egypt, Prof. W. Flinders Petrie; April 30: Serbian ideals, Miss Annie Christitch; May 3: The principles of technical evaporation and distillation, Dr. W. A. Caspari; May 4: Hindu religions, Prof. L. D. Barnett.

OXFORD.—Prof. J. Mark Baldwin, honorary professor of the University of Mexico, formerly professor of philosophy and psychology in the Johns Hopkins University of Baltimore, has been appointed Herbert Spencer lecturer for the year 1915–16.

ACCORDING to the *Korr. Norden*, lectures in the University of Berlin will be greatly reduced, on account of the number of professors and students at the front.

WE learn from *Science* that under the will of the late General Charles H. Pine, recently published, Yale College will eventually receive an addition of 30,000*l.* to the 10,000*l.* scholarship fund established by General Pine about three years ago. The will also provides for the creation of a fund of 50,000*l.* to be devoted to manual training of Ansonia boys and girls. From the same source we learn that by the will of General William D. Gill, of Baltimore, the Johns Hopkins University is made residuary legatee after the death of his wife. The bequest is to be used for the establishment of a chair of forestry. The sum of 5000*l.* has been contributed by Mr. P. S. du Pont toward the University of Pennsylvania Museum extension building fund, which now amounts to more than 20,000*l.* As soon as the fund amounts to 100,000*l.*, the building of the next extension will be started.

THE Civil Service Estimates for the year ending March 31, 1916, include a vote of 145,000*l.* for special grants in aid of certain universities, colleges, medical schools, and agricultural institutions, to meet loss of income arising during the war. It is pointed out that certain of the universities, colleges, and other similar institutions which are in receipt of Parliamentary grants have been adversely affected by the war, more especially by the loss of fee income arising from the widespread response among men students to the call for recruits. The special grants in aid will be used to give such assistance as may be necessary to save the institutions in question from suffering serious permanent detriment from the temporary emergency. The expenditure of the universities, colleges, and other institutions out of the grants will not be accounted for in detail to the Comptroller and Auditor-General, nor will any unexpended balances be surrendered by the payees at the close of the financial year.

DR. H. B. GRAY, formerly headmaster of Bradfield College, has recently been appointed official lecturer at the Imperial Institute in order to give short lectures on the resources of the countries of the Empire, illustrated by the collections of exhibits which are to be seen in the various courts assigned to those countries in the public exhibition galleries of the Institute at South Kensington. Since the beginning of last month a succession of such lectures has been delivered at the institute by Dr Gray, chiefly to schools in London and its neighbourhood, in connection with the school teaching of the geography of the Empire. In addition to these lectures to schools, it is now intended to arrange a weekly lecture in the exhibition galleries, of a less formal kind, for members of the general public in connection with the exhibits illustrative of the present condition and resources of the Colonies and India. The first of these lectures will be given on Wednesday, May 12, at 3 p.m., on Canada and Newfoundland, and will be followed each week in May on Wednesdays, at 3 p.m., by short illustrated lectures on other countries of the Empire in turn. A separate announcement will be made with regard to the lectures in June. No charge will be made for these lectures. Admission will be by ticket, to be obtained at the Imperial Institute, South Kensington. The number attending each lecture will be limited to fifty.

THE Journal of the Institution of Electrical Engineers contains an interesting paper and discussion on training for the industrial side of engineering. The paper is by Mr. A. P. M. Fleming, who described the apprentice school which the British Westinghouse Company established a year ago at their own works. Instruction averaging about five hours a week is given during working hours to all bound apprentices, numbering altogether about 300. The regular rate of wages is paid during the time spent in this way, and the cost of books and stationery is also defrayed. Teaching is done by twelve members of the engineering staff, supplemented by lectures from the leading foremen and shop engineers. Ten of the most promising apprentices are selected each year and sent for one whole day a week to the course for engineering apprentices at the Municipal School of Technology, Manchester. Mr. Fleming emphasised the unsuitability of the evening classes in most industrial centres for "trade" instruction, which he thought

was of comparatively little use to the youth who would be a workman all his life. On the other hand, he considered evening technical instruction excellent to give youths possessing ability and determination a means of rising from non-technical to technical employment. Prof. E. W. Marchant endorsed what Mr. Fleming had said with regard to evening classes, and said that it seemed to him a physical impossibility for a man engaged in manual or other labour during the day time to study effectively if he gets his technical education in the evening. On the other hand, Prof. Miles Walker, of the Manchester School of Technology, said that although day classes were better for those who could attend them, as the students would be fresher and better able to utilise their faculties, yet the men who came after their day's labour was over and did really good work three evenings a week with home lessons on Saturdays and Sundays must possess admirable qualities. Mr. J. Collinge referred to the difficulty of training young men engaged in central stations, who had not been able to afford college training, as owing to the character of the work and the hours they had to be employed they were largely prevented from regular attendance at technical schools, and consequently frequently found themselves in a "blind alley."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 22.—Sir William Crookes, president, in the chair.—Lord **Rayleigh**: Deep water waves, progressive or stationary, to the third order of approximation. The principles of hydrodynamics are applied to form the equations of wave-motion to the third order of approximation without restriction other than that the motion is irrotational and in two dimensions. The results are then applied to the progressive wave of permanent form, as investigated by Stokes, and to stationary waves. It appears that the form of the latter at the moment of greatest deviation from mean level is the same as that of the permanent progressive wave, but that the periods of vibration corresponding to the same wave-length are different.—Hon. R. J. **Strutt**: A chemically active modification of nitrogen, produced by the electric discharge. VI.—Dr. C. **Chree**: The difference between the magnetic diurnal variations on ordinary and quiet days at Kew Observatory. The paper considers the difference between the diurnal variations of magnetic force at Kew Observatory on quiet days and ordinary days (*i.e.* all days with the exception of those of large disturbance). The data employed are from the eleven years 1890–1900. Taking mean data for the whole year, the difference in the horizontal plane may be regarded as consisting, to a first approximation, of a harmonic oscillation of twenty-four hour period along a direction inclined 64° east of north and of a regularly progressive non-cyclic change in a second direction which is perpendicular to the former. The result, while true of the days of the year as a whole, is only imperfectly exhibited in most individual months.—F. **Horton**: The effects of different gases on the electron emission from glowing solids. An investigation has been made of the ionisation produced by a glowing Nernst filament when used as a kathode in a discharge tube in the presence of various gases of different chemical affinities for the material of the filament. It has been found that the actual electron emission from the filament is independent of the nature of the surrounding gas, at least for the gases, air, nitrogen, oxygen, and hydrogen, for at low pressures the thermionic currents measured under similar conditions in these gases were practically the same. At higher pressures the thermionic currents differ considerably owing to the effect of ionisation by collisions being different in the different gases. The increase in the current due to ionisation by collisions in hydrogen is much greater than it is in air, oxygen, or nitrogen. The experiments were repeated with a Nernst filament covered with lime, and it was similarly found that the electron emission from lime under these conditions was not increased by hydrogen, although earlier experiments have shown that lime heated on platinum gives a much larger electron emission in hydrogen than it does in air. This appears to be caused by the hydrogen increasing the emission from the platinum, an effect which has been shown by H. A. Wilson to be due to the absorption of hydrogen by the metal. Lime and the oxides of a Nernst filament do not absorb hydrogen, and the electron emission from these substances is therefore unaltered by the presence of this gas. That the electron emission from an oxide kathode is the same in oxygen and in hydrogen, gases which have very different chemical affinities for the material of the kathode, is evidence against the theory which has lately been put forward, that the electron emission from a glowing solid is due to chemical action between the solid and the surrounding gas.—W. S. **Tucker**: Heats of dilution of concentrated solutions. More detailed study of the variation of heat of dilution with concentration is here described than has hitherto been published. Dilution was performed by short steps by addition of water at air temperature. Specific heats of solutions were accurately obtained for various concentrations so that heats of dilution could be calculated for any mean concentration. Solutions of hydrogen and lithium chlorides and sodium hydroxide give results which appear to show a linear relation with mass concentration, for the range over which heat of dilution has an appreciable magnitude. Curves are shown which indicate that this heat of dilution, if that linear relation be accepted, will vanish at such concentration as will suggest the formation of some simple hydrate of the solute. Thus the straight line connecting heat of dilution and mass concentration for hydrochloric acid solutions will, if produced, cut the axis of concentration at $HCl,15H_2O$. Solutions of lithium chloride and sodium hydroxide similarly yield hydrates $LiCl,8H_2O$ and $NaOH,8H_2O$.—T. R. **Merton**: The origin of the "4686" series. An attempt has been made to obtain some information as to the origin of the "4686" series by measurements of the relative breadths of the "4686" line and the helium lines, from which the relative masses of the atoms concerned can be calculated according to the relations which have been found by Lord Rayleigh, Michelson, Buisson and Fabry, and others. The conclusion arrived at is that either the breadth of the "4686" line is controlled by circumstances at present unknown or that the line originates from systems of subatomic mass.

Zoological Society, April 13.—Mr. E. T. Newton in the chair.—E. **Gibson**: The Ñato cattle of the Argentine. The author exhibited the skull and a photograph of some specimens formerly in his possession which he believed to be the last of the breed.—Dr. G. E. **Nicholls**: The Urostyle (*Os Coccygeum*) of the anurous Amphibia.—G. A. **Boulenger**: The snakes of the Belgian and Portuguese Congo, Northern Rhodesia, and Angola. The paper contained a list of all the species known to inhabit this region, with keys to the identification of the genera and species, and the descriptions of two new forms from Angola and Katanga.—Dr. R. **Broom**: Some new carnivorous Therapsids in the collection of the British Museum. Most of the specimens described have been for many years in the collection, but owing to their small size

and imperfect condition they have not hitherto been recognised as new. Five species, belonging to four new genera, are Therocephalians. Two species, one of which belongs to a new genus, are Gorgonopsians, and one is a new species of a previously known Cynodont genus.—Dr. R. **Broom**: The organ of Jacobson and its relations in the "Insectivora" Tupaia and Gymnura. Gymnura is shown to have the same type as is found in Erinaceus, Sorex, and Talpa, and most higher Eutherians such as Felis, Lemur, Miniopteris, Ovis, Bos, Equus, Procavia. Tupaia, on the other hand, has, like the allied Macroscelides, the primitive marsupial type. Peters and Haeckel in 1864 and 1866 had suggested separating Tupaia and Macroscelides as a suborder of the Insectivora, but the condition of the nasal cartilages shows that the Menotyphla should form a distinct order, not even closely allied to the typical Insectivora.

Linnean Society, April 15.—Prof. E. B. Poulton, president, in the chair.—C. F. M. **Swynnerton**: Experiments and observations on the interpretation of form and coloration in plants and animals. Food-preference and other experiments were carried out over five years on insectivorous and (later) carnivorous, egg-eating herbivorous, and other animals, and numerous field-observations made. The work was attempted on a large scale and with every precaution, experiments on captive insectivorous birds were checked (and confirmed), by a series of experiments on wild birds, and various objections to a selectionist view specially tested. Numerous "deterrent" defences were found definitely to exist; also the finest gradation from those species of animals and plants that are only eaten through hunger, to the few that an individual enemy will eat to repletion-point. This indicated that the need for distinguishability from pleasanter forms (apparent and otherwise) is, and has been, widespread, and, with the numerous mistaken attacks and unmistaken refusals witnessed, suggested a contributory explanation for "distinctiveness" and diversity generally. Wild fruits were also "graded" by their eaters, and preferences shown by insects and birds as between even their own flowers; insect-hunting bird-parties were watched on a few occasions visiting exclusively particular temporarily-infested species of trees; and the utilisation of appropriate characteristics by animals for intra-specific recognition was amply illustrated by field-observation. Thus "distinctiveness" (and differentiation) may have been very widely selected in relation to "friends" too. Abundant observation of unmistaken attacks on prey and the latter's reply thereto testified to the great importance of the procryptic and actively evasive defences and to the fact of their appropriate utilisation. Moreover, enemies were seen to return expressly to stationary prey that they had not been hungry enough for on first discovery, and the view that a special handicap may prohibit conspicuousness in a group, a species, a stage, or a sex was confirmed otherwise too. That it is through the existence or development of suitable counter-agents (as flight, nauseousness, procryptic underside, and special habits) that whatever factors make for conspicuousness have been together enabled (in another species, sex, etc.) to produce it, was shown; and several such factors were indicated, including sexual selection. Animals were deterred by resemblances in prey, and a double potential basis for mimicry was found definitely to exist; also a basis for synaposematism (in flowers synepisematism) in the observed effect of the more numerous reminders and simplified recognition that a link in appearance or smell would afford. Probable cases of mimicry were seen and tested in plants, eggs, and birds. More than 800 attacks on butterflies by wild birds were witnessed. Discriminative action that might contribute to selection was actually observed at work, interspecifically (as in the preferences shown), and intraspecifically (in choice of largest available prey, destruction, or artificial entry of inconvenient ornithophilous flowers, and individual destruction through the inactivity of extra-floral nectaries).

Mathematical Society, April 22.—Sir J. Larmor, president, and afterwards Prof. Love, vice-president, in the chair.—G. H. **Hardy**: Note on Dirichlet's divisor problem.—Col. R. L. **Hippisley**: Note on a new form of closed linkage.—G. B. **Mathews**: Division of the lemniscate into seven equal parts.—Sir J. **Larmor**: The influence of the oceanic waters on the law of variation of latitude. The prolongation of the periodic time of the small free orbital motion of the pole over the earth's surface from 304 to 428 days has been recognised to be due to the centrifugal strain of the earth's rotation changing in step with the changing axis of rotation. This regular circular precession is found to be strongly disturbed by irregular surface displacements of terrestrial masses. But among these disturbances the adaptation of the ocean surface to the changing axis ought not to be included, for being synchronous with the precessional motion it must affect its period, and so fundamentally alter it instead of merely disturbing it. It is roughly estimated that if the earth were elastically unyielding, the effect of the existing ocean would be to lengthen the period of free precession from 304 to about 332 days. The remainder of the actual increase to about 428 days would be, as now, ascribed to elastic centrifugal strain of the solid earth, and the necessary slight revision of current estimates of its yielding is made on this basis. The question is broached, What would be the course of history of a planet so nearly spherical that the incumbent ocean would destroy secular stability for all possible axes of rotation?

DUBLIN.

Royal Irish Academy, April 12.—Rev. J. P. Mahaffy, president, in the chair.—Rev. P. **Browne**: An integral equation proposed by Abel, and other functional equations related to it. The paper deals principally with the equation, $\int_a^b G(t)f(tx)dt = g(x)$, where G and g are known functions, and f is to be discovered; a and b are constants. Abel gave this equation as a generalisation of the problem of the isochrone, stating he had solved it, but the solution does not appear in his published works. A solution is found involving integration along an infinite straight line in the plane of the complex variable. By extensions of the method, the equations,

$$\int_b^a G(x, t)\, f(tx)dt = g(x), \quad \int_0^{\prime}\int_0^{\prime} G(t, \tau)\, f(tx, \tau y)dtd\tau = g(x, y),$$

and others, are solved.—A. J. **Rahilly**: Some geometrical determinants. The geometrical determinants dealt with are of the type exemplified in Frobenius's theorem connecting the mutual powers of two quintets of circles. It is shown by a very simple method that similar determinantal relations exist between many sets of geometrical entities; in fact, a large part of the metric geometry of the point, line, circle, plane, and sphere may be reduced to such determinant-equations. Some new applications are given; in particular, Ptolemy's theorem, which is a special case, is given several extensions.

Royal Dublin Society, March 23.—Prof. W. Brown in the chair.—Prof. J. **Wilson**: Simplified solutions of certain Mendelian problems in which factors have inseparable effects. The author makes use of two

simple observations to prove certain problems discussed in a previous paper on unsound Mendelian developments. The observations are:—(1) If one or more groups in a set of hybrids' progeny carry a character outside those producing the set, that character is common to all the groups in the set. For instance, if the characters carried by the four following groups have been found as set down, namely: agouti, 9XY; cinnamon agouti, 3Xy; black, 3xYZ; chocolate, 1xy; then the character Z is carried by the three remaining groups, for otherwise black would differ from agouti and chocolate in more than one pair of characters, and from cinnamon agouti in more than two. (2) A character carried by more than half the groups in a set of hybrids' progeny is common to all the groups in the set. For instance, if the characters of three of the four groups in a set have been found as follows: agouti, 9XYZ; dilute agouti, 3; black, 3xYZ; blue, 1xYz; then dilute agouti must also carry Y, and, by the symmetry of the set, the additional characters X and z.—Miss A. **Wilson**: Changes in soils brought about by heating. The increased productivity of soil which has been subjected to different degrees of heat has been studied by E. J. Russell and F. J. Seaver and E. D. Clark. Russell suggests that the increased productivity is due to the increase in the number of nitrifying bacteria consequent on the destruction of the larger organisms by heat. Seaver and Clark and others maintain that the heated soil owes its greater productivity to the increased amount of soluble matter due to the decomposition of soil constituents. In these experiments extracts of suitably prepared soil heated to various temperatures between 60° and 150° during periods of two hours were obtained. The depression of freezing point and the electrical conductivity of each solution were then determined. It was found that there was a marked range in the coloration of the solutions thus obtained, and each solution gave a marked reaction to litmus. The amount of water retained by the heated soil was also noted in one set of experiments, and found to increase with the temperature to which the samples were heated. Throughout the experiments the depression of freezing point and electrical conductivity showed a marked increase in the solutions obtained from samples heated at the higher temperatures.

PARIS.

Academy of Sciences, April 19.—M. Ed. Perrier in the chair.—A. **Müntz** and E. **Lainé**: Studies on the agricultural value of the sediments carried by the watercourses of the Alps and Pyrenees. From the chemical point of view, these sediments have nearly the same proportions of fertilising materials as good average arable soils. They vary greatly in physical properties and measurements were made of the apparent density, porosity, capacity for water, and permeability of sediments from different sources. The permeability varies greatly, and the fine sediments tend to choke the irrigated soil. Experience has shown agriculturists making use of irrigation the best means of dealing with this tendency to impermeability.—C. **Guichard**: A series of surfaces and the equations of Laplace which are reproduced by a transformation (m, n) of Darboux.—V. **Grignard** and Ch. **Courtot**: Benzofulvanol and benzofulvene. Starting with the magnesium compounds of *cyclo*pentadiene, indene, and fluorene, and treating these with aldehydes and ketones, secondary and tertiary alcohols are obtained which have been named fulvanols, benzofulvanols, and dibenzofulvanols, and these, by dehydration, give the corresponding hydrocarbons. The preparation is described of the benzofulvanol obtained from indene magnesium bromide and trioxymethylene and the hydrocarbon benzofulvene obtained by its dehydration.—M. **Riquier**: Partial linear systems composed of equations equal in number to those of their unknown functions.—Rodolphe **Soreau**: Circular anamorphosis.—Pierre **Humbert**: The piriform figure of equilibrium of a fluid mass. Prof. Poincaré and Sir G. H. Darwin came to opposed conclusions as to the presence of points of inflexion on the section by a symmetrical plane of the equilibrium figure of a fluid mass in rotation. The author concludes that there are no points of inflexion and the calculations of Poincaré, pushed to the end, lead to the same result as those of Darwin.—B. Globa **Mikhailenko**: Modification of the ellipsoidal figures of equilibrium of a fluid mass in rotation under the action of capillary pressure.—M. **Drzewiecki**: Wind motors.—A. **Leduc**: The velocity of sound in gaseous mixtures. The application of a formula deduced in a previous communication to consideration of the velocity of sound in moist air, carbonic acid (Regnault's experiments), and mixtures of air and methane. The deviations between experiment and the author's theory are explained by the assumption that the latter is correct and that the gases used by Regnault and Capstick were impure.—Daniel **Berthelot**: The kinetics of photochemical reactions.—Ch. **Courtot**: The theory of the oscillation of the indene double linkage. The theory put forward by Thiele to explain his experimental results is unnecessary, since owing to an isomeric change unperceived by him he was dealing with only one benzylindene, the γ compound. The α-benzylindene has been prepared by the author, and is shown to be distinct.—M. and Mme. Fernand **Moreau**: Nuclear evolution and the phenomena of sexuality in the lichens of the genus Peltigera.—M. **Fonzes-Diacon**: Copper spraying fluids. The acid fluids have a high anticryptogamic action, the neutral and alkaline solutions are less active.

BOOKS RECEIVED.

Elementary Text-book of Economic Zoology and Entomology. By Prof. V. L. Kellogg and Prof. R. W. Doane. Pp. x+532. (New York: H. Holt and Co.) 1.50 dollars.

The Fauna of British India, including Ceylon and Burma:—Mollusca (Freshwater Gastropoda and Pelecypoda). By H. B. Preston. Pp. xix+244. (London: Taylor and Francis.) 10*s*.

Electrical Instruments in Theory and Practice. By W. H. F. Murdoch and U. A. Oschwald. Pp. viii+306. (London: Whittaker and Co.) 10*s*. 6*d*. net.

The Development and Properties of Raw Cotton. By W. L. Balls. Pp. xii+221. (London: A. and C. Black.) 5*s*. net.

Militarism versus Feminism. Pp. 64. (London: G. Allen and Unwin, Ltd.) 6*d*. net.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Edited by G. H. Warburton. Fifth edition, in 3 vols. Vol. iii. Pp. viii+483. (London: Macmillan and Co., Ltd.) 20*s*. net.

"Red Books" of the British Fire Prevention Committee. No. 196: Fire Tests with Glass. The Committee's Report. Pp. 20. No. 197: The Committee's Report. Pp. 16. (London: British Fire Prevention Committee.) 2*s*. 6*d*. each.

Heredity and Environment in the Development of Men. By Prof. E. G. Conklin. Pp. xiv+533. (Princeton: University Press; London: Oxford University Press.) 8*s*. 6*d*. net.

Histoire de l'Involution Naturelle. By Dr. H. Marconi. Pp. xii+505. (Paris: A. Maloine; Lugano: Maison d'Editions du "Cœnobium.") 15 francs.

Towards Racial Health. By N. H. March. Pp. ix+326. (London: G. Routledge and Sons, Ltd.) 3s. 6d. net.

Journal of the Natural History and Science Society of Western Australia. Vol. v. Pp. 109. (Perth, W.A.: V. K. Jones and Co.) 2s. 6d.

Castration of Domesticated Animals. By Profs. F. S. Schoenleber and R. R. Dykstra. Pp. x+154. (New York: Orange Judd Co.; London: Kegan Paul and Co., Ltd.) 1.25 dollars net.

The Syrphidæ of the Ethiopean Region based on Material in the Collection of the British Museum (Natural History), with Descriptions of New Genera and Species. By Prof. M. Bezzi. Pp. 146. (London: Longmans and Co., and others.) 6s.

Catalogue of the Amatidæ and Arctiadæ in the Collection of the British Museum. By Sir G. F. Hampson. Plates i.-xli. (London: Longmans and Co., and others.) 1l. 13s. 6d.

British Museum (Natural History). Instructions for Collectors. No. 12. Worms. Pp. 23. (London: British Museum, Natural History.) 3d.

A Revision of the Ichneumonidæ based on the Collection in the British Museum (Natural History), with Descriptions of New Genera and Species. Part iv. Tribes Ioppides, Banchides, and Alomyides. By C. Morley. Pp. x+167. (London: Longmans and Co., and others.) 6s.

Catalogue of the Fresh-water Fishes of Africa in the British Museum (Natural History). Vol. iii. By G. A. Boulenger. Pp. xii+526. (London: Longmans and Co., and others.) 2l. 5s.

British Museum (Natural History). British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report. Zoology. Vol. ii. No. 4. Pp. 61-112. Mollusca. Part 1. By E. A. Smith. (London: Longmans and Co., and others.) 4s.

British Museum (Natural History). British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report. Zoology. Vol. i. No. 3. Pp. 85-124. Cetacea. By D. G. Lillie. (London: Longmans and Co., and others.) 7s. 6d.

Chinese Forest Trees and Timber Supply. By N. Shaw. Pp. 351. (London: T. Fisher Unwin.) 10s. 6d. net.

Photomicrography. Third edition. Pp. 36. (London: Kodak, Ltd.) 3d.

A History of Persia. By Lieut.-Col. P. M. Sykes. 2 vols. Vol. i. Pp. xxvi+544. Vol. ii. Pp. xxii+565. (London: Macmillan and Co., Ltd.) 50s. net.

DIARY OF SOCIETIES.

THURSDAY, APRIL 29.

ROYAL SOCIETY, at 4.30.—The Transmission of Infra-red Rays by the Media of the Eye, the Transmission of Radiant Energy by Crookes's and other Glasses, and the Radiation from various Light Sources: H. Hartridge and A. V. Hill.—Surface Tension and Ferment Action: E. Beard and W. Cramer.—Surface Tension as a Factor controlling all Metabolism: W. Cramer.

ROYAL INSTITUTION, at 3.—Advances in General Physics: Prof. A. W. Porter.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Bombay Hydro-Electric Scheme: A. Dickinson.

ZOOLOGICAL SOCIETY, at 4.—Anniversary Meeting.

FRIDAY, APRIL 30.

ROYAL INSTITUTION, at 9.—Emulsions and Emulsifications: Prof. F. G. Donnan.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—Oil Well Engineering: W. Calder.

SATURDAY, MAY 1.

ROYAL INSTITUTION, at 3.—Photo-Electricity: Prof. J. A. Fleming.

MONDAY, MAY 3.

ROYAL SOCIETY OF ARTS, at 8.—Foodstuffs: Dr. D. Sommerville.

VICTORIA INSTITUTE, at 4.30.—Mahâyâna Buddhism and Christianity: Rev. Dr. W. St. Clair Tisdall.

ARISTOTELIAN SOCIETY, at 8.—Maine-de-Biran: Prof. A. Robinson.

SOCIETY OF CHEMICAL INDUSTRY, at 8.

TUESDAY, MAY 4.

ROYAL INSTITUTION, at 3.—The Animal Spirits: Prof. C. S. Sherrington.

ROYAL SOCIETY OF ARTS, at 4.30.—The Empire's Resources in Paper-making Materials: S. C. Phillips.

WEDNESDAY, MAY 5.

SOCIETY OF PUBLIC ANALYSTS, at 8.—*Discussion*: Methods adopted in the Estimation of the Nitrogenous Constituents of Extracts derived from Albuminous Substances, such as Meat Extracts and Similar Products, with Special Reference to the Interpretation of the Results.

ROYAL SOCIETY OF ARTS, at 8.—The Measurement of the Efficiency of Domestic Fires, and on a Simple and Smokeless Grate: Dr. A. V. Harcourt.

ENTOMOLOGICAL SOCIETY, at 8.—Descriptions of South-American Micro-Lepidoptera: E. Meyrick.—Experiments on Carnivorous Insects: C. F. M. Swynnerton.—The Larva and Pupa of *Caligo memnon*, Feld: F. L. Davis.

THURSDAY, MAY 6.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Some Problems Illustrating the Forms of Nebulæ: G. W. Walker.—Observations on the Resonance Radiation of Sodium Vapour: Hon. R. J. Strutt.—Local Differences of Pressure near an Obstacle in Oscillating Water: Hertha Ayrton.—Measurement of the Specific Heat of Steam at Atmospheric Pressure and 104·5°C. (with a Preface by Prof. H. L. Callendar, F.R.S.): J. H. Brinkworth.—Thermal Properties of Carbonic Acid at Low Temperatures. II.: C. F. Jenkin and D. R. Pye.

ROYAL INSTITUTION, at 3.—Advances in General Physics: Prof. A. W. Porter.

ROYAL SOCIETY OF ARTS, at 4.30.—Constantin Meunier et les Sculpteurs Belges de son Temps: M. Paul Lambotte.

LINNEAN SOCIETY, at 5.—Some Bird Problems: W. Percival Westell.—The Brown Seaweeds of the Salt-marsh: II.: Dr. Sarah M. Baker and Miss M. H. Bohling.—A Collection of Borneo Mosses made by the Rev. C. H. Binstead: H. N. Dixon.—Photographs of a Curiously-grown Tree from a Tunbridge Wells Garden: Rev. T. R. R. Stebbing.

FRIDAY, MAY 7.

ROYAL INSTITUTION, at 9.—Electrons and Heat: Prof. O. W. Richardson.

GEOLOGISTS' ASSOCIATION, at 8.—Radio-activity and the Measurement of Geological Time: A. Holmes.

SATURDAY, MAY 8.

ROYAL INSTITUTION, at 3.—Photo-Electricity: Prof. J. A. Fleming.

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